

IUST PUBLISHED '73 AUDIO-TRONICS

The great new 1973 edition of Lasky's famous Audio-Tronics catalogue is now available—FREE on request. The 48 newspaper size pages—many in full colour—are packed with 1,000's of items from the largest stocks in Great Britain of everything for the largest stocks in Great Britain of everything for the Radio and Hi-Fi enthusiast, Electronics hobbyist. Serviceman and Communication's Ham. Over half the pages are devoted exclusively to every aspect of Hi-Fi (including Lasky's budget Stereo Systems and Package Deals). Tape recording and Audio Accessories, see the great new Lasky's Credit Plan Scheme—enabling you to buy your ideal choice of equipment on easy terms. Send your name and address and 15p for post and inclusion on our regular mailing list. regular mailing list.

LEAK TEAK CASES

Teak or Walnut case for Stereofetic tuner only. LASKY'S £2.50 LIST PRICE £7:37 PRICE

Double case to hold Stereo 30 or Stereo 70 and Stereofetic tuner in Teak or Walnut.

LIST PRICE LASKY'S £4.95 C &



LEAK TRUSPEED

2-speed 45 and 33½ rpm belt drive turntable complete with plinth, cover and Shure cartridge.

LIST PRICE £69-50

LASKY'S 447.50 C&P PRICE

SINCLAIR PHASE LOCK LOOP STEREO FM TUNER



Incorporates varicap diodes, printed cir-cuit, coils, squelch circuit I.C. Decoder, etc., supplied completely built and tested and ready to

be mounted into any cabinet you choose. It may be used with any High Fidelity Amplifier. Power requirements 25/30V DC.

LIST PRICE LASKY'S £15.75

BSR TAPE DECK SCOOP



BSR TD2

FANTASTIC VALUE, ONLY Lasky's can offer you a tape deck at such an amazing price. The BSR TD2 tape deck operates by a simple reliable mechanism using the minimum of controls.

With & track mono heads. Incorporates fast wind and fast rewind, records at 37 ips, giving up to 3 hrs playing time, takes up to 54in. spools. Size 13in. 84in. front to rear, 248 in. below plate, I lin. above plate.

ALSO SUITABLE FOR USE AS A TAPE TRANSPORTER

ASKY'S £8.95 PRICE

C & P 35p

BELTEK C5700

Stereo car Player Accepts all standard pre-recorded 8 track stereo car-tridges. Features tridges. Features include automatic head cleaner, channel select and



channel select and channel repeat push buttons, slider type volume and tone controls, channel balance. Output 5 watts per channel, frequency response 50Hz-10kHz. Output imp. 4 ohms, size 4(W) × 1½(H) × 6½(D) in. Operates on 12V DC negative earth. Beautifully styled with black ivory and chrome trim.

BELTEK C5700 complete with mounting brackets and 8 track pre-recorded demonstration cartridge.

£21.00 C&P30p

BELTEK R5310 FM TUNING ADAPTOR Matches the C5700, the ideal car stereo system.

LASKY'S PRICE £18.95 C&P 25p

Add £3.75 to any BELTEK car player for pair of FANTAVOX KS701 car speakers.



AKAI TAPE RECORDER SCOOP !

(C & P 75p on all Tape Decks.)

Lasky's Price £61-50 AKAI 1720L List Price £87-36 Lasky's Price £58-95 AKAI X1800SD List Price £162-79 Lasky's Price £102-50

AKAI X200D List Price £157-93 CSS-8 Speakers Lasky's Price £100-50 CSS-8 Speakers
List Price £25:00 (pair) Lasky's Price £15-95
C & P 50p

2 ADM 11/8 mics. Suitable for use on all Akai tape recorders. List Price £11.90 Lasky's Price (pair) £7.50. C & P ISp.

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MODEL 600K

LASKY'S PRICE

£17.95

C & P 35p C&P35P
Powered by a 25,000 rpm, 115V, 75A Universal motor. This small versatile, easy to handle, power tool is ideal for handymen, hobbyists and professionals. The wide selection of bits helps you grind, sharpen, drill, rout, cut, etc. Perfect for delicate work and hard to reach places. The complete MINI-WORKSHOP is housed in a strong plastic carrying case. For 240V a.c. nains operation.
MODEL 600K place Kit contains:

Model 600
Power Unit
Accessory Caddy
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Sharpening Bits
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Plastic polish
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Complete with owners' manual
Size of power unit only 7½in.

LEAK SPEAKERS

£39.90 C & P £52.00 £2.50 £69.95 150 Speakers (pair)

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FROMLASKY'S
The clock measures 5½ (W) x 2½
(H) x 3* (D) (overall from front of
drum to back of switch). SPEC: 210/240V a.c. 50Hz
operation; switch rating 250V, 3A. Complete with
instructions. NOW WITH ILLUMINATED
DIAL COMPLETE WITH KNOBS
FEATURES: • MAINS OPERATION • 12HOUR ALARM • AUTO "SLEEP" SWITCH
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READ-OFF • FORWARD AND BACKWARD
TIME ADJUSTMENT • SILENT OPERATION
• SHOCK AND VIBRATION PROOF

SHOCK AND VIBRATION PROOF

SPECIAL QUOTES LASKY'S 26.50 C&P FOR QUANTITIES PRICE 25p

BSR TD8S

8 TRACK STEREO
CATRIDGE PLAYER
THE TOBS is suitable for
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stereo amplifers and delivers a
pre-amp output of 125mW. 35p
Power requirements: \$210/250V AC, 50Hz. Frequency
response: 50Hz-10KHz. 4 pole dynamically balanced
synchronous motor. Black and woodgrain plastic
cabinet. Size: 8½(W) × 3½(H) × 10½ (D) in.
List
LASKYS 4.7 FA

PRICE £17.50

Garrard Record Players

SP25 Mk, III Deck Only



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AP76			£18-85
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401			
40B			
2025TC with ster			
Zero 100			€39-95

NEW RECORD PLAYER MODULES

These new "Module" systems from Garrard and Lasky's enable you to buy your record player complete with attractive wood plinth, tinted acrylic dust cover and high quality compatible stereo magnetic cartridge together offering optimum performance and appearance

GARRARD MODULES

Garrard SP25 Mk. III turntable with Shure M75/6 cartridge Garrard AP76 turntable with Shure M75/6 cartridge Garrard AP96 turntable (single play version of \$1.958).
Garrard Zero 100\$ turntable with Shure M93/E cartridge

LASKY MODULES

LASKY'S (Garrard) SP25 Mk. III turn-table with Goldring G800 cartridge. Lasky's (Garrard) AP76 turntable with Goldring G800 cartridge. Lasky's (Goldring) GL75 turntable with Goldring G800 cartridge. Lasky's (Goldring) GL75 turntable with Goldring G800/e cartridge. C. & P.75p.

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Practical Electronics December 1972

Comoisseu B.D.1 Turntable kit

B.D.2 Press button speed change turntable



The Connoisseur BD2 belt drive turntable with press button speed change is an integrated turntable and pickup arm assembly, the raise/lower device of which is operated by the knob at the front right hand corner. The head shell allows for the lateral adjustment of the cartridge. The BD2 is supplied as

The B.D.1 well known for its superb performance and quality two speed working through a flexible belt drive system is now available in kit form. Construction is simplicity itself with no soldering required. Now it's so easy to own the best,

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SPECIFICATION Power output Freq. response Input sensitivity Construction Size

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MONTHS' OF THEIR BEING MADE AVAILABLE TO
THE GENERAL PUBLIC. WE ARE PLEASED TO
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INCLUDING THESE THREE MODULES.

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100 WATTS R.M.S. 11 transistors, 6 diodes

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PU70

15-40.000Hz + IdB 0.2% at 1kHz 4 to 16 ohms 15mA

Supply voltage

Circuits, connecting instructions and application data are supplied free with all modules.

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Stabilised module for 2 SA25's or two SA35's, **PS45** £35.0, carr. free M T45 Transformer for above, heavy duty, £2.85,

carr. 20p Transformer for unstabilised supply complete with rectifier diodes mounted, £3.50, carr. MT30

> Unstabilised supply for one or two SA100, £7.75, carr. 40p

Stabilised supply module for one or two SA100'8, £4-90, carr. free Transformer for PS70, £4-90, carr. 40p P\$70 MT70

ALL MODULES ARE BUILT ON GLASS FIBRE P.C. BOARD

SINGLE CHANNEL SOUND/LIGHT CONVERTER

This compact and reliable unit operates from amplifiers with outputs from 5-100W. Does not impose a heavy load on the amplifier, or, if connected in the wrong polarity, cause any damage, as with some units.

Operation is simplicity itself and the unit is fully fused. The unit is supplied to function from bass notes but may easily be converted to respond only to treble or mid-range notes by the addition of components costing less than 5p.



£8.90 carr. free

THREE CHANNEL SOUND TO LIGHT UNIT

Handling the total of 3,000W (3kW) this unit is unique for its price in that not only bass middle and treble but also master controls are provided. Two amplifier sockets eliminate the need for split leads, etc. Supplied in tough white steel case with a blue stelevtite hooded cover. Fully guaranteed. £19.75 carr.

MONO VERSION £6-50, carr. 20p (As illustrated below. S.A.E. details. 9V operation) OUTPUTS UP TO IV RMS



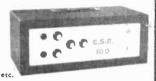
£15.80 carr. SAXON STEREO CONTROL UNIT

Two decks, and full headphone monitoring. The unit is mains operated and measures 17½ in × 3 in × 4 in deep and is finished with a smart white on black facia. The controls are: Left/Right deck fader, volume, bass, retelle, headphone selector and volume, microphone volume, bass, treble, mains on/off. THIS IS A MUST FOR THE HOME BUILT HIGH QUALITY DISCOTHEQUE AND IS COMPARABLE TO UNITS AT OVER TWICE THE PRICE.

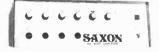
COMPLETE AMPLIFIERS THE CS 100. £34.90 carr. free

This versatile unit is now available in a black vynide case and so represents even better value than ever, delivering speech and music powers of up to 100W R.M.S. and continuous signal outputs of 70W.

Two individually controlled inputs with wide range bass and treble controls. Ideal for small groups, D.J's, etc.



The SAXON 100. £48.50, carr. free.



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Plays 12", 10" or 7" records. Auto or Manual. A high quality unit backed by BSR reliability with 12 months' reinspirity with 12 months guarantee. AC 200 250v. Size 13½ 11½in. Above motor board 3½in. below motor board 2½in.



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Single play Stereo Mono Derain transcription head and arm Four apeeds 10in. turntable. Anti-rumble filter. Bias compensation Laboratory motor



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Radio valve guide, Book 1, 2, 3, 4, 5 (each)					
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Boys' book of crystal sets and simple circuits					- 1
Universal gram motor speed indicator .					
High fidelity loudspeaker enclosures					- 4
Practical Stereo handbook					. :
Sound and Loudspeaker Manual					- 1
Coil design and construction manual					:
Radio, TV and electronics data book					. 2
Transistor circuits manual, No. 4				, ,	. 1
Practical transistor audio amplifier Book 1 .					. 4
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Engineers' and Machinists' reference tables		 			. 2
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Details S.A.E. Size 3; 1; 1; in.

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NEW TUBU		ELECTROLY	TICS	CAN TYPES	
2 350V	14p	250/25V	14p	50 + 50 350V	35p
4 350V	14p	500 25 V	20p	60+100'350V	58
8 450V	14p	1000 25V	35p	32+32 250V	180
16,450 V	15p	1000 50V	47p	32+32/450V	33 p
32 450V	20p	8+8 450V	18p.		
25 25V	10p	8+16'450V	20p	350 + 50 325V	50r
50.50V	10p	16+16 450	V 25p	32+32+32,350V	43p
100/25V	10p	32 + 32,350	V 25p	100 + 50 + 50 350 V	48
LOW VOLT	AGE 1	ELECTROLY	TICS.		
1, 2, 4, 5, 8,				15V 10p.	

150 mF 15V 15p; 25V 20p; 50V 30p.
150 mF 15V 15p; 25V 35p; 50V 30p.
200 mF 15V 17p; 25V 35p; 50V 47p; 100V 70p.
200 mF 6V 25p; 25V 45p; 50V 57p.
250 mF 50V 62p; 300 0mF 25V 47p; 50V 65p.
500 mF 6V 25p; 12V 42p; 25V 75p; 35V 85p; 50V 85p.

CERAMIC, 1pf to 0 01mF, 4p. Silver Mica 2 to 5000pF, 4p. PAPER 350V-01 4p, 0.5 13p; 1mF 15p; 2mF 150V 15p. 500V-001 to 0.05 4p; 0.1 5p; 0.25 8p; 0.47 25p. SILVER MICA. Close tolerance 1... 22-500pF 8p; 560-2.200pF 10p; 2,700-5,600pF 20p; 3,800pF-001, mid 30p each. TWIN GAMG. "0-0" 208pF 117pF, 65p; 510w motion drive 365pF+365pF with 25pF+25pF, 50p; 500pF standard 45p; single gamg 500pF 75p; small 3-gamg 500 pF £1-60. SHORT WAVE SINGLE. 10pF, 30p. 25pF, 55p. 50pF, 55p.

SHORT WAVE SINGLE GANG. Precision Silver Plated Gangable Tuning Condensers. 50p each Values up to 100pF. Cach Section Couplers supplied PREE with two or more gangs.

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Primary 8-110 240v. Secondary 0 240v. 3 amps. 720 watts. Insulated terminals. Varnish impregnated. Fully enclosed in steel case with fixing Ieer. £10 carr. Famous make. (Value £19) OUR PRICE 50p. Can be used as 800 watt auto transformers 240-110V.

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Osc. P50 1AC		Driver Trans. LFDT4	580
I.F. P50 2CC 470 kc s		Printed Circuit. PCA1	58p
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P51 1 or P51 2 .		Wevrad Booklet	10p
P50 3V	36p i	OPT1 .	58p
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With flared tweeter cone and ceramic magnet, 10 watt.
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8 ohm. 10 watt. Large ceramic magnet Special Cambric conc surround. Frequency response 30-12,000 cps. Ideal P.A. Columns. Hi-Fi Enclosure Systems, etc.



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The moving coil disphragm gives a good radiation pattern to the higher frequencies and a smooth extension of total response from 1,000 cps to 18,000 cps. Size 3½ × 31½ × 2in. deep. Rating 10 watt. 3 ohm or 15 ohm models.

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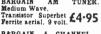
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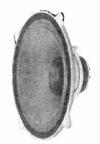
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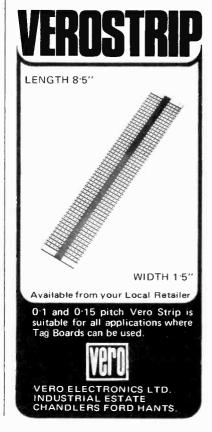
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2G301 20p 2G302 20p 2G303 20p	2N3417 8 2N3439 18	17p 28102	25p BC116 25p BC118 25p BC119	15p BFW91 25p NKT223 27p 15p BFX12 25p NKT224 25p 15p BFX13 25p NKT225 25p 30p BFX29 25p NKT225 35p	CASO00 180p FJH121 25p 8N7441 20p CASO05 117p FJH141 25p 75p	OA2 88p, 25Z4 80p, EL95 88p OB2 48p 25Z5 42p EM80 48p OZ4 80p 25Z6 88p EM81 80p IL4 20p 30C15 80p EM84 88p
2G306 42p 2G308 30p 2G309 30p	2N3564 1 2N3565 1	7p 28301 5p 28302 2p 28303	50p BC121 50p BC122 60p BC125	20p BFX30 25p NKT237 25p 20p BFX37 30p NKT238 25p 15p BFX44 37p NKT240 27p	CA3007 862p FJH151 25p 8N7442 75p CA3011 75p FJH161 70p 8N7446 100p CA3012 88p FJH171 25p 8N7447 185p	IL4 20p 30C15 80p EM84 85p IR5 40p 30C17 90p EM86 100p IS5 80p 30C18 80p EM87 70p
2G371 15p 2G374 20p 2G381 22p	2N3568 2 2N3569 2	28304 25p 28301	75p BC126 82p BC134 85p BC135	20p BFX 68 67p NKT241 27p 12p BFX 84 25p NKT242 20p	CA3013 105p FJH181 25p 8N7448 125p CA3014 124p FJH221 25p 8N7450 20p	IT4 25p 30F5 85p EY51 40p 1U4 80p 30FL1 75p EY80 40p
2N388A 49p 2N404 20p	2N3572 9 2N3605 2	7p 28503 7p 3N83	27p BC136 40p BC137	15p BFX86 25p NKT244 17p 15p BFX87 25p NKT245 20p	CA3018 84p FJH231 25p 8N7451 20p CA3018A FJH241 25p 8N7453 20p FJH251 25p 8N7454 20p	2D21 35p 30FL14 95p EZ40 55p 3Q4 50p 30L15 85p EZ41 50p
2N696 15p 2N697 15p 2N698 25p	2N3607 2 2N3638 1	27p 3N128 22p 3N140 .8p 3N141	70p BC138 77p BC140 72p BC141	20p BFX88 20p NKT261 20p 35p BFX89 62p NKT262 30p 35p BFX93A 70p NKT264 20p	CA3019 849 FJJ101 509 8N7460 209 CA3020 1269 FJJ111 509 8N7472 309 CA3020A FJJ121 609 8N7473 409	384 359 30L17 809 EZ80 279 3V4 489 30P12 809 EZ81 299 5R4 759 30P19 859 GZ32 489
2N699 30p 2N706 10p 2N706A 12p	2N3641 1	90p 3N142 8p 3N143 8p 3N152	85p BC147 67p BC148 87p BC149	10p BFY11 42p NKT271 80p 10p BFY18 25p NKT262 20p 12p BFY19 25p NKT274 20p	160p FJJ131 60p 8N7474 40p CA3021 155p FJJ141 125p 8N7475 45p CA3022 180p FJJ181 75p 8N7476 45p	5V4 85p 30PL1 75p GZ34 60p 5V4 45p 30PL13 98p KT66 205p 5Y3 40p 30PL14 90p KT88 200p
	2N3643 2 2N3644 2	25p 40050 25p 40250 25p 40251	55p BC152 50p BC153 82p BC154	17p BFY21 42p NKT275 20p 20p BFY24 45p NKT278 25p 20p BFY29 40p NKT281 27p	CA3023 126p FJJ191 65p 8N7483 87p CA3026 100p FJJ211 125p 8N7486 33p CA3028A 74p FJJ251 125p 8N7490 87p	5Z4G 409 35L6 509 MU14 759 6/30L2 809 35W4 359 PABC80 409
2N718A 30p 2N726 30p 2N727 30p	2N3691 1 2N3692 1	5p 40309 8p 40310 5p 40311	82p BC157 45p BC158 85p BC159	15p BFY30 40p NKT401 87p 11p BFY41 50p NKT402 90p 12p BFY43 62p NKT403 75p	CA3028B FJL101 125p 8N7492 87p 105p FJY101 25p 8N7493 87p	6AG7 40p 35Z5 50p PC88 60p 6AK5 35p 50B5 50p PC97 45p
2N914 17p 2N916 17p	2N3694 1 2N3702 1	8p 40312 0p 40314	47p BC160 37p BC167	35p BFY50 20p NKT404 55p 11p BFY51 20p NKT405 75p	CA3029A L900 40p SN7496 87p	6AK6 60p 50C5 50p PC900 48p 6AL5 20p 80 55p PCC84 40p 6AM6 30p 85A2 50p PCC85 40p
2N929 22p 2N930 20p	2N3704 1 2N3705 1	0p 40315 1p 40316 0p 40317	87p BC168B 47p BC168C 87p BC169B	10p BFY52 20p NKT406 62p 11p BFY53 15p NKT451 62p 11p BFY56A 57p NKT452 62p	CA3030 187p L923 40p 8N74153 CA3035 122p LM380 21 22p 135p CA3036 72p MC724P 60p 8N74154	6AQ5 38p 807 50p PCC88 55p 6A86 40p 1625 50p PCC89 50p 6AT6 35p 5763 70p PCC189 55p
2N987 40p 2N1090 22p 2N1091 22p	2N3707 1	9p 40319 1p 40320 7p 40323	85p BC169C 47p BC170 82p BC171	12p BFY76 42p NKT453 47p 12p BFY77 57p NKT713 20p 15p BFY90 65p NKT717 42p	CA3039 82p MC780P 247p 8N74160 200p CA3041 109p MC788P 146p 180p CA3042 109p MC790P 124p 8N74161	6AU6 25p 6146 160p PCF80 80p 6AV6 30p AZ31 55p PCF82 84p 6BA6 25p CY31 35p PCF84 60p
	2N3709 2N3710	9p 40324 9p 40326 2p 40329	47p BC172 87p BC175 80p BC177	15p B8X19 17p NKT734 27p 22p B8X20 15p NKT736 35p 20p B8X21 20p NKT773 25p	CA3043 187p MC792P 66p 260p CA3044 120p MC799P 66p 8N74164 220p MC1303L 220p	6BE6 80p DAF91 80p PCF86 60p 6BH6 75p DAF96 45p PCF800 80p 6BJ6 50p DF91 22p PCF801 50p
	2N3713 18 2N3714 20	37p 40344 30p 40347	27p BC178 57p BC179 52p BC182	20p B8X26 45p NKT781 30p 20p B8X27 47p OC16 50p 10p B8X28 32p OC19 37p	CA3046 81p 200p 8N74165 . CA3047 137p MC1304P 225p 8N74192	6BQ7A 40p DF96 45p PCF802 50p 6BR7 90p DK91 40p PCF805 80p 6BR8 70p DK92 55p PCF806 70p
2N1306 25p 2N1307 25p	2N3716 18 2N3773 24		40p BC182L 40p BC183 50p BC183L	10p B8X60 82p OC20 75p 9p B8X61 62p OC22 50p 9p B8X76 15p OC23 60p	CA3049 160p MC1305P 386p 8N74193 CA3050 185p MC838P 549p 175p	6BW6 85p DK96 50p PCF808 75p 6BW7 80p DL92 35p PCL82 35p
2N1309 25p 2N1507 17p	2N3819 8 2N3820 5	40970 40406	82p BC184 57p BC184L	11p B8X77 20p OC24 60p 11p B8X78 25p OC25 40p	CA3052 168p MC1435P TAA241 CA3053 48p 845p 162p	6C4 38p DL96 45p PCL84 45p 6CD6 125p DM70 40p PCL85 40p
2N1631 85p 2N1632 80p	2N3854 2 2N3854A 2		40p BC186 52p BC187 55p BC212L	27p B8Y25 15p OC28 60p 12p B8Y26 17p OC29 60p	CA3055 240p 461p TAA243 150p CA3059 165p MC1709CG TAA263 75p	6CL6 50p DY86 32p PCL86 45p 6CW4 65p DY87 33p PFL200 65p 6F1 62p E88CC 100p PL36 55p
2N 1637 30p 2N 1638 27p 2N 1639 27p	2N3855A 8 2N3856 8	30p 40467A	62p BC213L 50p BC214L 57p BCY10	12p B8Y27 15p OC35 50p 15p B8Y28 17p OC36 60p 27p B8Y29 17p OC41 22p	CA3064 120p 94p TAA293 97p FCH101 85p MFC4000P TAA300 175p FCH111 105p 55p TAA310 125p	6F6G 85p E180F 100p PL81 50p 6F13 45p EABC80 35p PL82 45p 6F14 70p EAF42 35p PL83 45p
2N 1701 162p 2N 1711 24p 2N 1889 82p	2N3858 2 2N3858A 8	25p 40528 30p 40600	85p BCY30 72p BCY31 57p BCY32	27p B8Y32 25p OC42 25p 30p B8Y36 25p OC44 15p 50p B8Y37 25p OC45 12p	FCH121 105p 8N7400 20p TAA320 72p FCH131 50p 8N7401 20p TAA350 175p FCH141 105p 8N7402 20p TAA435 147p	6F15 65p EB91 20p PL84 40p 6F18 50p EBC41 55p PL500 75p 6F23 85p EBC81 30p PL504 80p
2N1893 37g	2N3859 2 2N3859A 3	27p 40603	30p BCY34 20p BCY38	25p B8Y38 20p OC46 15p 30p B8Y39 22p OC70 15p 40p B8Y43 50p OC71 12p	FCH151 105p 8N7403 20p TAA521 182p FCH171 105p 8N7404 20p TAA522 360p FCH181 105p 8N7405 20p TAA530 495p	6H6 17p EBF80 40p PY32 55p 6J4 50p EBF83 40p PY33 68p 6J5 25p EBF89 32p PY80 40p
2N2193 401 2N2193A 421 2N2194 271	2N3866 15 2N3877 4	10p AC127	24p BCY39 20p BCY40 18p BCY41	60p B8Y51 82p OC72 12p 50p B8Y52 82p OC73 80p 15p B8Y53 87p OC74 80p	FCH191 105p 8N7406 80p TAA811 445p FCH201 180p 8N7408 20p TAB101 97p FCH211 180p 8N7409 20p TAD100 150p	6J5GT 80p EBL21 60p PY81 80p 6J6 20p EC86 60p PY82 85p 6J7 45p EC88 60p PY83 88p
2N2194A 80g 2N2217 25g	2N3900 8 2N3900A 4	37p AC152	22p BCY42 22p BCY43 20p BCY54	15p B8 Y54 40p OC75 22p 15p B8 Y56 90p OC76 22p 82p B8 Y79 45p OC77 30p	FCH221 130p 8N7410 20p TAD110 150p FCH231 150p 8N7411 23p 8L403D 150p	6K8G 40p ECC40 65p PY88 40p 6L6GT 45p ECC84 80p PY800 40p
2N2219 201 2N2220 251	2N3903 2 2N3904 2	20p AC187 AC188	25p BCY58 25p BCY59 27p BCY60	22p B8 Y90 57p OC78 20p 22p B8 Y95A 12p OC81 20p 97p C424 15p OC81D 20p	FCJ111 150p 8N7413 80p UA702A 280p FCJ121 275p 8N7416 84p UA702C 77p	6Q7 40p ECC88 40p U25 80p 68A7 40p ECF80 35p U26 80p
2N2222 20g 2N2222A 25g	2N3906 2	25p ACY 18 12p ACY 19	24p BCY70 24p BCY71	15p C450 15p OC82 25p 20p GET102 80p OC82D 15p	FCJ131 275p 8N7417 84p UA703C 187p FCJ141 525p 8N7420 20p UA709C 45p FCJ201 100p 8N7423 51p UA710C 125p	68G7 40p ECF82 35p U50 40p 68J7 40p ECF86 65p U52 35p 68K7 40p ECH21 57p U191 75p
2N2368 15g 2N2369 15g	2N4060 1 2N4061 1	10p ACY20 12p ACY21 12p ACY22	20p BCY72 20p BCY78 10p BCY79	30p GET114 20p OC84 25p 30p GET118 20p OC139 25p	FCJ211 275p 8N7427 48p UA716 187p FCK101 480p 8N7428 80p UA723C 100p FCL101 280p 8N7430 20p UA730C 160p	68L7 35p ECH35 100p U281 40p 68N7 35p ECH42 75p U282 40p 68Q7 40p ECH81 30p U301 40p
2N2369A 15p 2N2410 42p 2N2483 27p	2N4244 4 2N4248 1	12p ACY28 47p ACY39 15p ACY40	17p BCZ10 47p BCZ11 20p BD112	27p GET120 25p OC140 82p 40p GET873 12p OC170 25p 50p GET880 80p OC171 80p	FCY101 102p 8N7432 48p UA741C 80p BRIDGE 50PIV 4A 4Cp	6U4 65p ECH83 45p U801 180p 6V6G 25p ECL80 45p UABC80 40p 6V6GT 32p ECL82 35p UAF42 55p
2N2484 321 2N2539 221 2N2540 221	2N4249 1 2N4250 1 2N4254 4	18p ACY41 18p ACY44 12p AD140	25p BD121 47p BD123	112p GET887 20p OC200 40p 65p GET889 22p OC201 60p 80p GET890 22p OC202 75p	RECTIFIERS	6X4 35p ECL83 70p UBC41 50p 6X5G 30p ECL86 40p UBC81 40p 6X5GT 40p EF37A 120p UBF80. 40p
2N2613 35; 2N2614 30; 2N2646 40;	9 2N4255 4 9 2N4284 1	12p AD149 17p AD150 17p AD161	47p BD124 62p BD131 85p BD132	75p GET897 22p OC203 40p 80p GET897 22p OC204 40p 80p GET898 22p OC205 75p	800PIV 1A 50p 50PIV 6A 45p 50PIV 2A 45p 100PIV 6A 55p	10C2 50p EF39 50p UBF89 85p 10F1 75p EF40 50p UCC84 49p 10P13 60p EF41 65p UCC85 40p
2N2711 25 2N2712 25 2N2713 27	2N4286 1 2N4287 1	17p AD162 17p AF109 15p AF114	35p BDY10 45p BDY20	125p MAT100 25p OC206 95p 105p MAT101 25p OC207 75p 125p MAT120 25p OCP71 42p	100PIV 2A 50p 200PIV 6A 65p 200PIV 2A 55p 400PIV 6A 75p 400PIV 2A 60p 600PIV 6A 85p	10P14 110p EF42 70p UCF80 55p 12AT6 80p EF80 25p UCH21 60p 12AT7 80p EF85 85p UCH42 70p
2N2714 807 2N2904 207 2N2904A 257	2N4289 1 2N4290 1	17p AF115 12p AF116 15p AF117	25p BDY62 25p BF115 20p BF117	100p MAT121 25p ORP12 50p 25p MJ400 107p ORP60 40p 47p MJ420 80p ORP61 42p	SILICON RECTIFIERS MINIATURE WIRE ENDED PLASTIC	12AU7 30p EF86 30p UCH81 40p 12AX7 30p EF89 28p UCL82 35p 12AV6 40p EF91 30p UCL83 60p
2N2905 251 2N2905 A 201 2N2906 201	2N4292 1 2N4294 1	15p AF118 17p AF121 47p AF124	60p BF152 80p BF154 22p BF158	28p MJ421 80p P346A 22p 20p MJ430 102p 8T140 15p 15p MJ440 95p 8T141 20p	SERIES IN PL CL 1 AMP 1.5 AMP 3 AMP 4001 50PIV 7p 8p 19p	12BA6 40p EF92 35p UF41 60p 12BE6 40p EF183 35p UF80 35p
2N2906A 25; 2N2907 23;	2N4964 1 2N4965 1	15p AF125 18p AF126	19p BF159 19p BF163	85p MJ480 97p T1834 62p 85p MJ481 125p T1843 40p	4002 100P1V 7p 9p 20p 4003 200P1V 8p 10p 22p 4004 400P1V 8p 10p 25p	12BH7 45p EF184 35p UF85 40p 19AQ5 35p EH90 40p UF89 40p 20D1 50p EL34 50p UL41 65p
2N2924 151 2N2925 151	2N5028 8	52p AF127 57p AF139 47p AF178	16p BF167 28p BF170 42p BF173	18p MJ490 100p T1844 10p 88p MJ491 187p T1845 27p 19p MJE340 50p T1846 11p	4005 600 PIV 10p 12p 26p 4006 800 PIV 12p 15p 27p	20F2 65p EL41 60p UL84 46p 20L1 110p EL42 65p UY41 48p 20P1 50p EL81 55p UY85 40p
2N29260 101 2N2926Y 101	P 2N5172 1 P 2N5174 4	42p AF179 12p AF180 52p AF181	45p BF177 50p BF178 40p BF179	309 MJE370 80p TIS47 11p 25p MJE371 80p TIS48 12p 80p MJE520 60p TIS49 12p	4007 1000PIV 15p 16p 30p 50+ less 15% 100+ less 20% RILICON RECTIFIERS	20P3 60p 20P4 110p 20P5 120p EL85 48p VR155/3088p 20P5 120p EL85 48p Add 13p in 2
2N3011 201 2N3014 881 2N3053 181	2N5176 4 2N5232A 2	52p AF186 45p AF239 30p AF279	30p BF180 30p BF181 47p BF182	35p MJE521 70p T1850 12p 32p MPF102 42p T1851 10p 30p MPF103 35p T1852 11p	8TUD MOUNTING 6A 10A 17-5A 35A 100PIV — 45p 50p \$1-22	DIODES & RECTIFIERS
2N 3054 461 2N 3055 601 2N 3133 301	2N5245 4 2N5246 4 2N5249 6	45p AF280 42p AFZ11 57p ASY26	47p BF184 82p BF185 25p BF194	20p MPF104 87p T1853 22p 20p MPF105 87p XB112 12p 15p MPS3638 22p XC141 25p	200PIV 25p 50p 55p £1.42 400PIV 30p 55p 62p £1.77 600PIV 38p 60p 72p £2.18	1N34A 10p BA154 12p GJ7M 87p 1N914 7p BAX13 12p OA5 17p 1N916 10p BAX16 7p OA6 12p
2N3134 801 2N3135 251	2N5265 33 2N5305 3	25p ASY27 87p ASY28 40p ASY29	80p BF195 24p BF196 27p BF197	15p NKT124 42p ZTX107 15p 15p NKT125 87p ZTX108 12p 15p NKT126 87p ZTX109 15p	800PIV 35p 75p 87p \$2.47 1000PIV 40p 85p \$1.05 \$2.77 50+ less 15% 100+ less 20%	AA119 7p BAY31 7p OA9 10p AA129 10p BAY38 15p OA10 28p AAZ13 10p BY100 15p OA47 8p
2N3390 25; 2N3391 20;	2N5307 8 2N5308 8	87p A8Y50 87p A8Y51 82p A8Y54	25p BF198 32p BF200 25p BF224	15p NKT128 27p ZTX300 12p 35p NKT135 27p ZTX301 15p 14p NKT137 32p ZTX302 20p	ZENER DIODES	AAZ15 10p BY103 22p OA70 7p BA100 15p BY122 37p OA73 10p BA102 30p BY124 15p OA79 7p
2N3392 17; 2N3393 15;	2N5310 4 2N5354 8	A8Y67 27p A8Y86 27p A8Z21	45p BF225 82p BF237 51p BF238	199 NKT210 809 ZTX303 809 829 NKT211 809 ZTX304 859 829 NKT212 809 ZTX500 169	3·3-33V 2·4-100V 3·9-100V 10p each 85p each 40p each	BA110 25p BY126 12p OA81 8p BA111 27p BY127 15p OA85 7p BA112 70p BY164 52p OA90 7p
2N3402 22p 2N3403 22p	2N5356 8 2N5365 4	17p BC107	150p BF244 10p BFW61 10p BFW87	28p NKT213 80p ZTX501 15p	25+ less 15% 100+ less 20% TRANSISTOR DISCOUNTS:— 12 + 10%; 25 + 15%; 100 + 20% any one type.	BA115 7p BY210 35p OA91 7p BA141 32p BYZ11 30p OA95 7p BA142 32n BYZ12 30n OA200 7p
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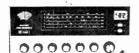


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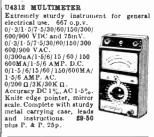
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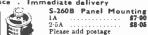
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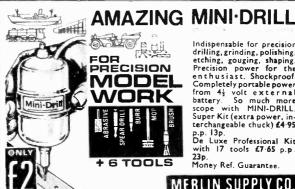
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AC187K	25 p	BC149				2N 3704			10p
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0.022μ F	3p	$0.47 \mu F$	8p
$0.033 \mu F$	3р	0 68µF	11p
$0.047 \mu F$	3p	IμF	13p
0.068µF	31/2p	1.5µF	20p
0.IμF	4p	2.2µF	24p
0.15µF	4p		

Mullard C281 - 400V

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0.033µF	51/ap	0 33μF	14p
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0.068µF	6р		

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2.5	4		10	16	25	40	64
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10	8	6.4	4	2.5	1.6	1	0.64
40	32	25	16	10	6.4	4	2.5
80	64	50	32	20	12.5	8	5
160	125	100	64	40	25	16	10
320	250	200	125	80	50	32	20

TT (4111	ar c	7 6	. Y.	7/	G	U	
2.5	4	6.4	10	16	25	40	64	
1000	800	640	400	250	160	100	64	8p
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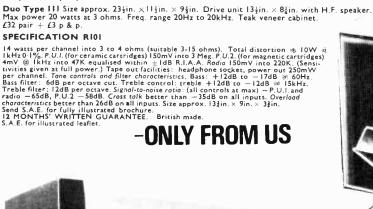
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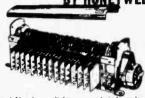
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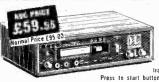
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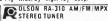
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As reviewed in POPULAR HI.FI REALISTIC 30 WATT STEREO February 1972 AMPLIFIER MODEL SA-500 A superb hi-fi amplifier with all the fea-tures you've ever wanted – for under £46-00. Saving over £10.00 on the normal ROC PRI retail value. Up-to-the-minute slider controls for bass and treble, Separate volume and balance controls. Headphone socket on front panel. Push-button input controls — magnetic phono (high/low) tuner, aux, mono, monitor, Loudness push-button control for perfect sound at low autput levels, Left and right push-button on/off switches for speakers. Noise filtering

Size 16" wide, 4" high, 9" deep. Cabinet in walnut, Including connecting leads.

and tape monitoring facilities. Two auxiliary AC outlets. Frequency response 20-20,000 Hz \pm 1 db at full power, 15 watts rms per channel. Walnut cabinet with satin aluminium trims. Inputs: phono 2-5mV and 5mV RIAA; tuner/aux 250mV. Hum and noise: phono - 50db: tuner/aux - 65db. How's that for a specification!
Size 14% wide, 3½ high, 10% deep



This ROC Tuner is especially de signed to match the Olson AM-395 Stereo Amplifier. In price and value, as well as it's good look-ing design! But of course it's also

ideal for use with any other amplifier. The RA-310 costs £10-00 less than the normal retail value, and yet it is a highly sophisticated unit, incorporation is drift free for sup-

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controls. An elloupness switch for coosting the bess and trable notes when littening at low output levels. Frequency response: 20-20,000 Hz \pm 368. Output: 20 wetts r.m.s. per channel into 8 ohms. Inputs. magnetic phono 3 0mV RIAA, crystal phono 100mV; tape 160mV; tuner 160mV. Size 11 \pm 7 wide, 47 high, 7½ deep. The specification reads well – sounds evan better!



A-3000 36-WATT SOLIO STATE STERED AMPLIFIER The A-3000 looks as good as it sounds? Giving you a big performance this superb audio amplifier has a full range of facilities on the front and rear panels. On the front — all the controls you're ever likely to need plus a headphone socket. On the rear signal inputs, speaker outputs and a line fuse for circuit protection.

Specifications: 18 watts rms per channel into 8 ohms. Frequency response 20-35,000 Mz (± 2db) Inputs Magnetic, Ceremic, Tuner, Tape, Aux, Tape Play, Size: 345mm × 300mm × 130mm,



Q 25-WATT 3-WAY

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Inputs: phono 80mV; tuner/aux 80mV. Size 8" wide, 23" high,

SPEAKER CE-56 This high quality speak er has its own built-in

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ROC 7-WATT STERED AMPLIFIER CHASSIS SK-317 This exclusive Charriele completely self-contained, and it costs £2-25 less than the normal r than no normal retail value! The SK-317 is a really compact unit measuring only \$5 * wide. 12* high and \$8" deep, it contains its own mains power supply, and has a garged volume control and separata trable controls for each channel. Specification: frequency research

ponse 40-17 000 Hz \pm 3dB; output 3-5 watts music power par channel into 8 ohms; input; phono, 600mV; signal-to-noise ratio better than 45dB.



OLSON AM-372-16-WATT STEREO AMPLIFIER Here's a really good amplifier at a really down-to-earth price. nearly £7 less then the normal retail value! Just look at what the AM-372 will do for you - reproduce signals from ceramic or crystal cartridges, AM and FM tuners, and tape recorders. And it gives you outputs for two sets of speakers, headphones and tage recorders Frequency response is 30 to 20,000 Hz ± 3dB. Output 8 watts r.m.s. per channel music power into 8 ohm speakers. Phono input 200mV. Tuner input 200mV. Size: Phono input 121" wide, 31" high 71" deep.

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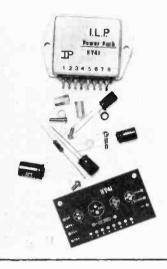
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The HY41 supersedes the popular HY40 introduced by ILP last year. This highly improved module achieves true High Fidelity with a dramatic reduction in distortion (typically 0.05% at 1KHz into 8 ohms!) and is electronically and mechanically compatible with the HY40.

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The free manual gives a full circuit diagram of the HY41 and its various applications including a complete stereo amplifier.

Like its predecessor the HY41 is based on conventional and proven circuit techniques developed over recent years.

OUTPUT POWER: British Rating 40 WATTS PEAK, 20 watts

R.M.S. continuous.

LOAD IMPEDANCE: 4–16 ohms.

INPUT IMPEDANCE: 30K ohms at 1KHz.

VOLTAGE GAIN: 30db at 1KHz

TOTAL HARMONIC DISTORTION: less than 0.15% (typical 0.05%)

at 1KHz.
FREQUENCY RESPONSE: 5Hz-50KHz ± 1db.

SUPPLY VOLTAGE: ± 22.5volts D.C. SUPPLY CURRENT: 0.8 amps maximum.

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Two distinctive features of the HY5 are its inbuilt stabilization circuit, allowing it to be run off any unregulated power supply from 16-25 Volts and a balance circuit which, when linked by a balance control to a second HY5, forms a complete stereo pre-amplifier

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Magnetic Pick-up (within ± 1 db RIAA curve) 2mV. 47K Ω Tape Replay (external components to suit heed). 4mV. 47K Ω

need). 4mV. 47K_M
Microphone (flat) 10mV. 47K Ω
Ceramic Pick-up (equalized and compensatable) 20–2000mV. variable.
Tuner (flat) 250mV. 100K Ω
Auxiliary 1 250mV. 47K Ω

Auxilfary 2 2-20mV. 100K Ω

Main Pre-amp output 500mV. Direct tape output 120mV

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INTERNAL STABILIZATION
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SUPPLY VOLTAGE

16-25 volts

PRICE MONO: £3,60 SUPPLY CURRENT 6mA approx. OVERLOAD CAPABILITY

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VOL. 8 No. 12 December 1972

PRACTICAL ELECTRONICS

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FIFTY YEARS OF BROADCASTING

Anniversaries are always useful when they provide excuse to pause and look back over some really significant period. The pause is fully justified on the occasion of the BBC's 50th birthday. There is no question that these 50 years of broadcasting in the U.K. have had tremendous and lasting effect upon the individual and upon society as a whole. The history of broadcasting is also the history of the emergence of electronics, although the precise origins of both are indefinable or controversial, and go back certainly far beyond a half century.

In November 1922 the British Broadcasting Company was formed by a group of leading wireless manufacturers, at the behest of the G.P.O. This action followed years of agitation by various individuals and groups in this country. One of the most active pressure groups was the Wireless Society of London (later the Radio Society of Great Britain) representing the large number of amateur constructors and experimenters the new medium of wireless communication had already attracted. At the time, broadcasting was already in full swing in the United States where more than 300 registered stations were operating; in Europe regular broadcasts had been made from The Hague since 1920; while in this country irregular transmissions had been made throughout this period by the Marconi Company.

In 1926 the BBC was reconstituted as a public corporation by Royal Charter, fully committed to the public service concept by its indomitable chief executive J. Reith (later Lord Reith). High-minded principles and the uncompromising way in which they were applied produced a powerful, influential monopolistic organisation which has always been the centre of much controversy. The BBC during the past 50 years has been held up as an example of public service at its best, by some; while it has been condemned as an autocratic body out of touch with (or indifferent to) contemporary public opinion, by others. Political attitudes aside, all objective observers must acknowledge and pay respect to the integrity of purpose and high standards insisted upon and maintained consistently throughout these 50 years by the BBC, in both programme and engineering matters.

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Our January issue will be published on Friday, December 8

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RALLY DRIVING GAME By D. R. Daines

A game using a simple operational amplifier to simulate some of the characteristics of a car rally.

THE average car-race game suffers from two major drawbacks: all the cars taking part usually have identical characteristics and there is little or no room for skill. Here in a simple and inexpensive unit both drawbacks are overcome.

Not only are five different cars offered for use, with differing road-holding, braking and acceleration characteristics, but skill in manipulating brake and throttle is hard to come by. Players must use this skill in order to drift round corners at the maximum speed permissable without skidding off. Obviously, the winner will be the player who can acquire this skill the quickest.

The whole unit is completely self-contained and can be built for about £3, using spare materials for the case.

BASIC RALLY GAME IDEA

On the left of the front panel (see photograph) is a bank of five press-switches with the names of five cars, one of which must be selected before the unit can operate. Next to it is a variable resistance that is set to represent the present speed that the car is supposed to be travelling—from 0 to 100 m.p.h.

Brake and throttle are simulated by variable resistances, but other than identification labels there are no dial markings round the track of the pointer knobs; players must accustom themselves to their particular car and use judgement in their setting.

In the centre of the front panel is a flap that conceals a voltmeter and when the player has adjusted the previous controls he lifts the flap to read his resultant speed. Since I volt represents one square of advancement on a playing board and also represents 10 m.p.h., conversion is easy.

When the player's car enters a corner, he sets a rotary switch to represent the severity grading of the corner and then presses a push-button. If the lamp above lights up, the car is deemed to have skidded off. Full details on how to play the game are given at the end of this article.

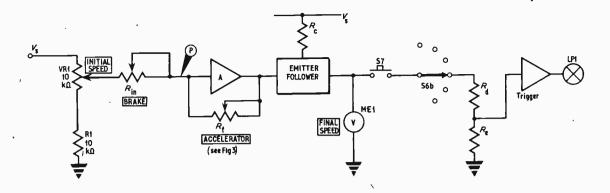


Fig. 1. Simplified circuit showing principle of operation

SIMULATION CIRCUIT

Fig. 1 shows a simplified schematic diagram of the whole unit. A 12V positive supply is presented to VR1, the SPEED control, which is arranged in a simple voltage divider system. Since R1 is equal to VR1, the minimum voltage output is half the supply, i.e. 6 volts.

The resistor is used because if VRI was returned directly to earth, the input of the amplifier would also be earth and the output to the meter would be nil. Hence when starting off from rest the cars would achieve a speed of nothing; racing their engines without letting the clutch out, so to speak.

The next unit is a very interesting one that is really the heart of the system. It is a direct current amplifier with considerable negative feedback. Since it is direct current that is being amplified, capacitance coupling is out of the question and recourse must be made to direct coupling. The circuit used is a direct coupled d.c. amplifier which has a large input impedance, a very large gain, and considerable negative feedback, otherwise termed an operational amplifier.

OPERATIONAL AMPLIFIER

Let us assume that the gain of the amplifier is 10,000 and that the voltage out is 10 volts. This would mean that the voltage at point "P" in Fig. 1 is $10 \div 10,000 = 0.001$ volt and considerable current is flowing back through $R_{\rm f}$ to maintain this very low figure—virtually at earth potential. It follows that increasing the value of $R_{\rm f}$ will reduce this cur-

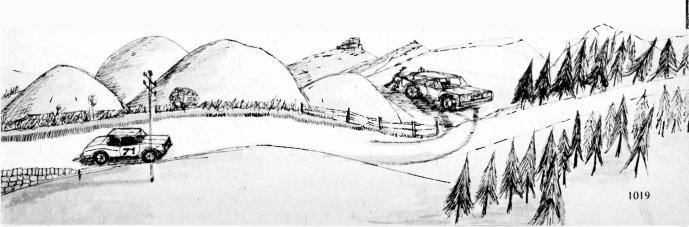
Table 1: VALUES OF INPUT VOLTAGE TO ACHIEVE 10V OUTPUT (where possible)

R _{in}	$R_f = 3.3 k \Omega$	$R_{\rm f} = 4.7 \text{k} \Omega$	$R_{ m f}{=}$ 6.8k Ω	$R_t = 8.3 \text{k} \Omega$
68k Ω	11.0V	8-5V	6.5V	5.75V
83k Ω	9.0V max	9.9V	7.5V	6.6V
97k Ω	5.4Vmax	11.5V	8-6V	7.6V
118k Ω	1.0V max	6.8V ma	x 10.6V	9-3V

rent, raise the voltage at point "P" and raise the output voltage.

 $R_{\rm in}$ has the opposite effect; raising this value will lower the voltage at point "P" and hence the output voltage. The analogy to accelerator and brake is obvious; $R_{\rm f}$ becomes the accelerator and $R_{\rm in}$ becomes the brake. See Table 1.

Of course $R_{\rm in}$ and $R_{\rm f}$ have upper and lower limits. The upper limits are no problem, but by adjusting the lower limits we may readily obtain different responses to the variable resistors. These are set to the individual car characteristics. (See Table 2 and Fig. 2). It will be seen from Fig. 2 that there is a choice of fixed resistors of differing values. Which one is chosen depends upon which switch is pressed. Then there is a small fixed resistor common to all and finally VR2, which is the brake. The total resistance equals $R_{\rm in}$.



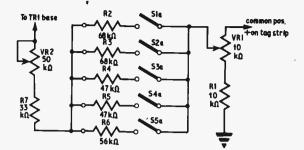


Fig. 2. Breaking is simulated by R2 to R6 switched in the brake position $\rm R_{i\,n}$

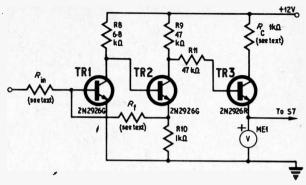
Table 2: RESISTOR BIAS VALUES

CAR (switch no.)	R _{in} (brake)	R _f (acce- lerated)	R _c (max. speed)	R _e (road holding)
1	68k	2-2k	4.7k	6-8k
2	68k	3⋅3k	Nil '	5-6k
2 3	47k	4⋅7k	4-7k	5.6k
4 ,	47k	3-3k	2-2k	8-2k
5	56k	2·7k	Nil	Nil
VR	50k	5k	_ /	

Fig. 3 shows the operational amplifier and its associated low output-impedance stage. The circuit is surprisingly simple; TR1 and TR2 form the amplifier. Since they are direct coupled as a super-alpha pair, their individual current gains are multiplied. Notice particularly from where the feedback is taken. At this point (TR2 emitter) the voltage rise is out of phase with the base of TR1 and hence negative feedback.

In the prototype, the car-selection switches were only two-pole (see components list), so another selection of fixed minimum values were not provided for the feedback. However, from experimental work that has been done on the prototype, and for those readers who might prefer to use three- or four-pole switches, values have been given in Table 2. Not much can be gained in this way, however, and those who wish to incorporate only two-pole switches can be happy in the knowledge that the system works well.

An emitter-follower TR3 provides a lowimpedance output that will not load the previous stages. The meter is arranged so that the resistance of the meter coil provides the emitter resistance.



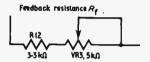


Fig. 3. The basic operational amplifier with the practical feedback resistance $\mathbf{R}_{\mathbf{f}}$

Normally, the collector is returned to the positive rail directly, but the insertion of resistor R_c in the collector lead will reduce the maximum output voltage. This is a useful facility for those who would like to limit the maximum speed of different cars; values are given in Table 2.

ROAD-HOLDING

From the meter, the current goes to a push-button (S7 in Fig. 1) which is included for three reasons. Firstly, there will be many game moves in which a corner is not encountered; secondly, illumination of the lamp would give players a valuable clue as to the position of the meter; and finally, current consumption is very low at 6mA, but jumps to over ten times that figure when the button is depressed and the lamp lights.

The corner selection switch S6 selects, in the first position, the battery on/off, while each of the other five positions selects a voltage-divider such as is shown as R_d and R_e . All resistors in R_d are connected together and fed to the Schmitt trigger, while those in R_e are selected by the car press switches. Thus the actual voltage division that takes place depends upon the severity of the corner and the car selected. See Fig. 4.

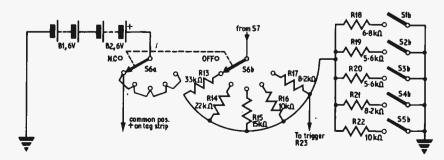


Fig. 4. Switching for road holding ability

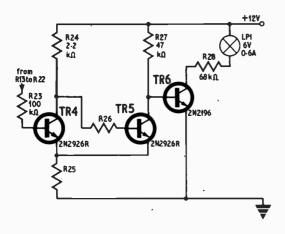


Fig. 5. Switch trigger and lamp driver

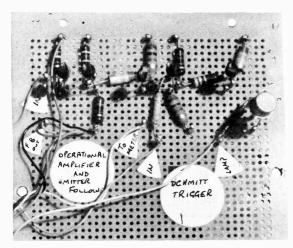
SCHMITT TRIGGER

Transistors TR4 and TR5 in Fig. 5 form a Schmitt trigger that will trigger the output of TR5 when the incoming voltage rises to 1.5 volts. When TR5 turns on, TR6 switches off, hence nearly 6V appears across the lamp, making it glow. The resistor in series with the lamp is a current limiter.

CONSTRUCTION

The constructor should start by obtaining his bank of press switches. There are many types available and many suitable as far as the circuitry is concerned. The panel may then be cut and drilled to suit, following the dimensions given in Fig. 6. The hole for the meter may require adjustment as well as extra fixing holes.

The hole in the top right-hand corner is to view the lamp. This was just drilled and countersunk, but readers may prefer to use a coloured plastics



Rally driver circuit board

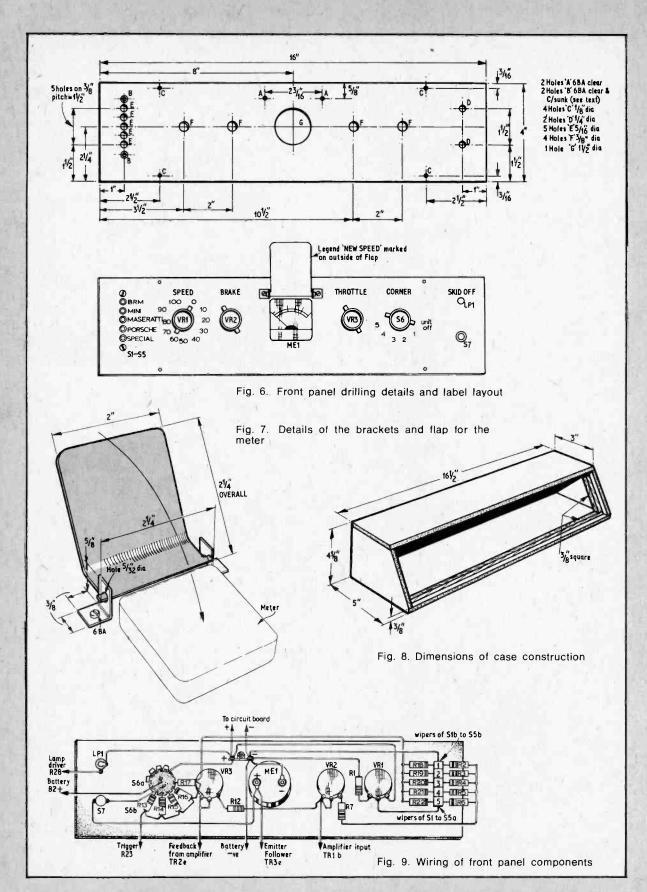
Before the panel can be painted, the meter-cover flap must be made. (Fig. 7). The two small brackets were made from thin (24 s.w.g.) tinplate, while the flap was made from thicker (18 s.w.g.) aluminium; as was the panel. A small $\frac{1}{8}$ in $\times \frac{1}{8}$ in lug was left on each of the two top corners to fit in the $\frac{5}{3}$ in holes in the brackets. This provides a very simple hinge for the flap. Notice that the flap has a 30 degree bend across it so that it lies flat on the face of the meter. When complete, glue a strip of felt on the underside in order to prevent scratches on the cover glass.

When the flap has been fitted—the meter having just been offered in position—the panel can be painted and put to one side while the case is made.

Make the bottom of the case next, ensuring that it is the same length as the panel (Fig. 8). Cut this from $\frac{1}{8}$ in ply for rigidity, then cut two ends from $\frac{1}{4}$ in ply to the dimensions given; glue and pin them over the ends of the base. Cut the top also from a sheet of $\frac{1}{4}$ in ply. Make sure that it is exactly the length of the base plus the two ends, then glue and pin it on top of the ends.

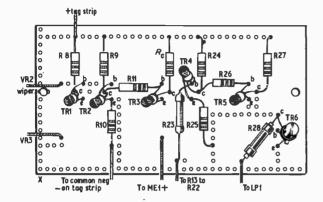
Glue and pin ½in square fillets inside the front to take the panel, and on the base to hold the batteries. When the glue has set, smooth all surfaces and prepare for paint or polish. Fit rubber mushroom feet to the base.





WIRING

All the switches, potentiometers and the meter can now be mounted on the panel and the wiring as shown in Fig. 9 undertaken. Seven wires lead off to the circuit board; leave these at least 4in long. To save confusion, it is best if these wires are colour-coded. The battery clips are joined so as to connect the two 6V batteries in series; the negative wire is taken to the tag strip, and the positive to one central tag of S6.



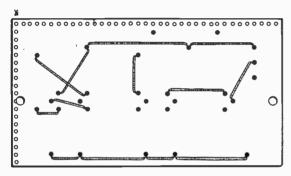
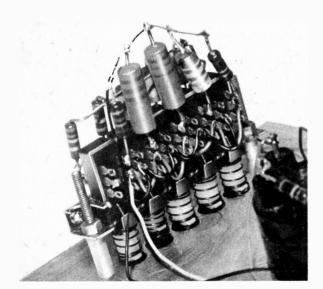


Fig. 10. Layout of components on s.r.b.p. circuit board and underside wiring



Wiring of switches S1-S5

CIRCUIT BOARD

It will be seen from the photographs that there is ample room inside the case and that a small circuit board will hold all the active components. The components are arranged in two distinct sections, sharing a common 12 volt supply line and a common earth. A suggested wiring layout is shown in Fig. 10.

Solder all the wires to appropriate points on the circuit board before putting it all into the case. Check all wiring against the circuits before connecting the batteries and testing. If for any reason the operational amplifier is not functioning as it should, adjustment of resistors in R_{in} or R_f or both may solve the difficulty.

When all is satisfactory it can be assembled in the case. The circuit board sits on top of the bottom front strip and on a similar strip at the back, while the batteries are held by similar wood strips glued to the case. The panel is fastened to the fillets by four ½in chrome-plated screws. Finally, a back of hardboard may be pinned into place, its edges chamfered and smoothed.

COMPONENTS . . .

Resist	ors				/	
R1	10k Ω	R11	47k Ω	R21	8.2k Ω	
R2	68k Ω	R12	3-3k Ω	R22	10k Ω	
R3	68k Ω 👡	R13	33k Ω	R23	100k Ω	
R4	47k Ω	R14	22k Ω	R24	2.2k Ω	
R5	47k Ω	R15	15k Ω	R25	$1k\Omega$	
R6	56k Ω	R16	10k Ω	R26	33k Ω	
R7	33 k Ω	R17	8-2k Ω	R27	47k Ω	
R8	6.8k Ω	R18	6-8k Ω	R28	68Ω	
R9	47k Ω	R19	5-6k Ω	R _c S	See text	and
R10	1kΩ	R20	5-6k Ω	Tabl	e 2	
All -	+ 10% + wa	att carbo	n			

Potentiometers

VR1 $10k \Omega$ linear carbon VR2 $50k \Omega$ log. carbon VR3 $5k \Omega$ linear carbon

Transistors

TR1, TR2 2N2926G TR2, TR3, TR4, TR5 2N2926R or O TR6 2N2196

Meter

ME1 Voltmeter 10V f.s.d. type MRA38 or similar

Lamp

LP1 6V 0.06A m.e.s. with holder.

Switches

S1 to S5 Push button 2 or 4 pole changeovers on common frame with reset, or separate toggle switches

S6 2-pole, 6-way rotary wafer switch S7 Single-pole, push button on/off

Batteries

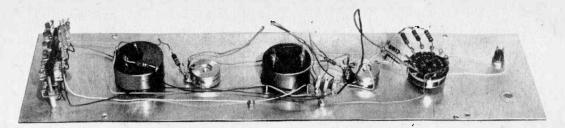
B1, B2 6V each style PP1 (2 off)

Miscellaneous

Battery connectors (2 pairs) Aluminium panel $16in \times 4in$ Plywood $\frac{1}{4}in$ for case and $\frac{1}{2}in$ square section

Component wiring board or printed circuit board approx. 4-5in × 4in or less

Glue, pins, knobs



Components mounted on rear of rally driver front panel

GAME PREPARATION

A large sheet of card is obtained (the larger the better) and a road route marked out on it containing plenty of junctions, bends and corners of differing severity. Hazards, landmarks, buildings and other obstacles can be incorporated to choice. It is worth marking lanes into spaces or car-lengths. Mark a starting/finishing line, and grade each corner and hazard.

PLAY 1

Toy cars are placed in each lane at the starting line. Players may toss a coin for choice of lane. The last player to place his car has the privilege of moving off first. Each player specifies which type of car he is using and of course must stick to it throughout the game. A note is made of all choices. There is no limit to the number taking part, and any number of players may specify the same type of car.

In his turn, each player adjusts VR1 to his present speed, presses the switch for his type of car, then adjusts brake and/or throttle to his satisfaction. He lifts the flap and reads the voltmeter to the nearest whole division. Once he has lifted the flap he cannot readjust the controls until his next turn; he must lower the flap again afterwards. The player then moves his car the number of car lengths equal to the meter reading up to a maximum of ten lengths.

If during the course of this move he encounters a corner, he sets S6 to the numbered grading of that corner, from 1 to 5, with "1" being a slight bend and "5" the inside track of a hairpin. He then presses the button and if the lamp lights he spins off the track and misses the next turn. The turn after that he restarts from where he spun off.

LANE DISCIPLINE

Only one car is allowed in a square at a time. Changing lanes is permissible, provided that in the lane into which he wishes to move or cross, there is no car nearer than four lengths behind; that is, there must be three clear lengths.

Cars wishing to overtake another may therefore be boxed in by a third and in these circumstances he must match his speed with the slower car in front. Failure to do so—that is, if his move would ordinarily take him beyond the car in front—means that he again must spin off the track and miss a turn.

Of course, players may use this technique deliberately to force a car behind off the road, and there will be many cases where a player over-compensates or grossly mishandles'the brake, bringing his car to a halt in the path of another. Unless the one behind can overtake without hindering a third, or unless he too can halt, then he must spin off and miss a turn.

CONCLUSION

Constructors preparing a track may have as many bends as they wish, but at least one good straight should be included—particularly if the top speed of some cars is limited in the manner described. Hazards such as chicanes and islands could also be introduced and constructors should bear in mind that the inside lane on a bend may have fewer carlengths in it, but rate a higher corner-severity.

Much of the success of the game and the enjoyment derived is in the road layout, and it will probably be worthwhile to collaborate on this with someone who has had real rally driving experience.







SOVIET SPACE PROBES

Some additional information has now become available from Russia which relates to the *Mars-2* and *Mars-3* space probes. Some of the work done by *Mars-3* has already been reported here. The additional information was obtained with infra-red radiometers operating in the 8 to 40 micrometre band.

The system of measurement was such that the tracks of the probes went from the southern hemisphere to the northern hemisphere of Mars, going through the seasons and all parts of the day. The temperature of the surface of Mars was plotted through these periods and showed that the variation was from $-13\,^{\circ}\text{C}$ to $-93\,^{\circ}\text{C}$.

From this data a clue can be obtained as to the structure of the surface, and the climate can be assessed. The low temperatures at night seem to indicate that the surface cools quickly after sunset. If this is the case then it points to the heat conductivity of the surface as being low and consistent with dust or dry sand in a comparatively rarefied atmosphere.

Generally speaking, there was a difference between the dark areas or seas, and the light areas or continents. The seas were warmer by some 10°C and this is no doubt due to lower reflective power in these areas. This is true of one special area, a dark region known as Cerberus, which lies north of the Cimmerian sea. It is likely that the higher heat conductivity is due to rocks projecting from the surface.

In February when the probe Mars 3 was in the region of the northern ice cap the infra-red radiometer recorded a temperature of -110°C. Such a reading indicates that the polar cap consists mostly of solid carbon dioxide.

This cap remains all through the year. There is also indication of some water-ice. The southern ice cap disappears in summer.

DRY MARS

The Soviet scientists have said that it is possible that the north polar cap contains more carbon dioxide and water than in the whole of the Martian atmosphere. The actual precipitation of water on Mars is about 0.02 of that of the earth's atmosphere. Mars, therefore, is much drier than earth based experiments and measurements indicated.

The dust storms on Mars still remain a mystery. Measurements have shown that the particles of dust are about one micrometre in size. These would settle very slowly, thus these dust clouds often endure for up to three months. One thing that has been noted with these clouds is that an increase in wavelength of observation can make them more transparent to the scanning photometer. Some particles are found to be as much as ten micrometres in size but these settle very quickly.

It is interesting to note that the two spacecraft from the Soviet Union have relied on astrophysical instruments for their observations whereas the United States have relied mostly on television. Such combination of observations should yield a much more positive accumulation of data for comparison.

So far the information from the various probes since 1965 has led to comparisons of earlier measurements. For example, in 1969 Mariner probes 6 and 7 recorded atomic hydrogen levels substantially higher than those recorded by Mars-2 and Mars-3. The possible explanation is that either there is now a smaller amount of water vapour present, or that the temperature has fallen.

Finally, the presence of a shock wave due to the solar wind interacting with the upper levels of the Martian atmosphere, was detected.

GALAXY THAT EXPANDS FASTER THAN LIGHT

Radio telescopes at California and Massachusetts, working as an interferometer with 100 million wavelengths as a base line, and enabling changes of 0.001 second of arc to be detected, were focused on the source 3C 120, a quasar.

Astronomers D. B. Shaffer, M. H. Cohen, David Jauncey and K. Kellerman were examining the fine structure of this source and when they compared the present results with some made about eight months before, they observed considerable structural changes in the source. The movements observed, when

reduced to a measurement of velocity, indicates that the "blobs" of matter were moving apart at two to three times the speed of light.

There have been previous records in two quasar explosions which indicated speeds faster than light. However, the uniqueness of this new result lies in the fact that whereas the two previous events were quasars with a high red shift, about which some astronomers now have doubts, the results from 3C 120 are from a source of quite low red shift. In this case there is no longer the criticism that the apparent high speed is because the distance from the earth is much less than supposed. The distance of 3C 120 is not in question. The situation. has thrown the whole problem into a turmoil again.

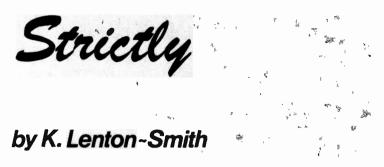
CRUST OF THE MOON

The artificial production of seismic events on the moon by crashing spent stages and lunar module ascent stages plus one authentic meteorite of about six feet in diameter, have now provided a great deal of data from the seismic observatories on the moon. Altogether there have been about six artificial impacts and these have enabled the reflections from the various layers of the moon to be measured.

There is a sharp increase in velocity from 0.1km per second at the surface to 5km per second at a depth of 10 kilometres. These figures are consistent with the structure of the moon soil and fragmented rock. As the depth increases the velocity would be expected to increase due to the compacting of the rocks. At a depth of about 25km there is a sudden increase in velocity to 6.8km per second and this continues down to a depth of 65km. Down to 25km the structure is consistent with basalt but from there on to the 65km level there must be some other type of rock. At this level also there is another change in velocity which rises to 9km per second. The geologists working on the projects maintain that this indicates a major structural boundary which may be the junction of the crust and the mantle.

The meteoritic impact revealed that the upper mantle velocity was similar to that of the earth with a velocity of 8.2km per second. If this is so, the moon may have a mantle similar to earth.

The measurements also suggest that there is a core at a depth of about 600km. This is the first direct evidence of a core. Having got so far, the last opportunity for direct observation comes in December with Apollo 17. At the moment it would seem that the crust of the moon is twice as thick as that of the earth.



ELECTRONIC MUSIC (as distinct from amplified conventional instruments) is often thought to be a relatively modern subject. In one sense it is, if *Music Concrete* is implied. In its real sense, the roots go back nearly 150 years, the recent pace having accelerated through technological advances.

C. G. Page described his music production methods in 1837 in the American Journal of Science in an article entitled "The Production of Galvanic Music". In the following year, C. E. L. Delezenne published a paper describing how a contoured iron wheel, rotated in front of an electromagnet, could produce a musical signal.

Professor Thaddeus Cahill patented his Teleharmonium in 1897, consisting of 58 alternators. As amplification was then unheard of, each alternator produced a musical frequency which could be played directly into a telephone system: the sine wave outputs could be mixed to produce various tone colours—so pointing the way for those who were to lay down, some 40 years later, the basic principles behind many modern electronic musical instruments.

MUSIC CONCRETE

The BBC Radiophonic Workshop and Daphne Oram are names that will be familiar to those interested in Music Concrete.

To produce this kind of music a tape recorder with 12 interchangeable capstans is required: with this, any sound may be recorded to produce a chromatic scale, provided that the source frequency is fairly steady. Re-recording this tape at different tape speeds on another machine will provide super- and sub-octaves of the sound source: careful cutting and splicing of these tapes can be done to produce a musical composition containing brilliant arpeggios and other unusual effects. A drum, cymbal (a very complex sound) or even a tap dripping into a basin are typical of the sound sources used in this work.

Rhythmic sounds are normally

produced by tape loops, perhaps using the basic source after its frequency has been taken down several octaves. After rhythm, melody, and special effects have been combined and reverberation added, the end result will either be fascinating or unpalatable—according to one's personal taste.

This type of work calls for several tape recorders and other special equipment, such as variable tone sources, re-iterators and reverberation devices. It is thus somewhat out of the amateur's field, except for the most rudimentary experimentation. The author admires the patience and skill of those prepared to make their music this way, but this type of work is not, of course, Strictly Instrumental

EARLY INSTRUMENTS

No real progress was made until amplification became a reality. Then, many ingenious inventions followed, most of which are now merely interesting curios.

The Trautonium, developed by Dr Friedrich Trautwein of the Radio Research section at the Berlin Academy of Music, was demonstrated in Berlin in 1930 and created considerable public interest.

The circuitry was fairly simple—an amplified relaxation oscillator: later versions had some tonal variation and an improved fingerboard. It was the electronic equivalent of a one-string-fiddle, the charge-discharge characteristic of the neon tube being the same sawtooth as obtained by drawing a bow over a string.

Another early instrument was the Theremin, which employed the principle of heterodyning two r.f. oscillators to produce an audio beat-note Frequency variation of one oscillator was achieved by hand capacitance, using a small antenna: the player thus had to "feel" for his pitch, much like a string player. Though rapid passages were impossible, it was effective as a legato, solo instrument: vibrato and glissando were easy to accomplish.

Martenot produced a similar instrument, using a fingerboard to alter capacitance in the inductively coupled circuit.

MONOPHONIC

It is easy to overlook the fact that a number of highly skilled musicians play monophonic instruments (brass and reeds, for example). Whereas the pianist or organist might be disinclined to consider a melody instrument, a monophonic device still has its uses.

The Hammond Solovox came on the scene about 30 years ago and was used by small bands as another solo voice. The fact that it soon had a number of imitators was proof of its success. The small, three-octave keyboard was designed to be fixed adjacent to the upper half of a piano keyboard, the master oscillator covering the entire 37 note range. Three divider stages followed and, with the master oscillator, their outputs were labelled, Soprano, Contralto, Tenor & Bass. Any one-or combinationof these could be switched to a common busbar feeding a series of five tone filters. With a knee-operated swell and controls for attack and vibrato, the Solovox was a useful instrument in any small "combo"

The monophonic instrument can only sound one note at a time (or its suboctaves), whereas the organ/electric piano is fully polyphonic. In looking at earlier instruments, the development of polyphonic instruments has been ignored on this occasion: this is because the youngest member of the monophonic family—the Synthesiser—is important to many of today's musicians and constructors. The last few paragraphs may thus have helped, in a way, to trace its ancestry.

THE SYNTHESISER

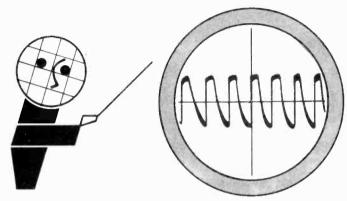
From the circuitry point of view, we have come a very long way from the Trautonium! The attraction of the modern synthesiser is, however, the same as it was over 40 years ago—an entirely new sound. Multiple recording can produce existing, and often weird results.

The complexity of voltage controlled oscillators, envelope and noise generators, modulators, etc. means that the polyphonic synthesiser is still a twinkle in the eye of its commercial father. I.C. manufacturers are going through the throes of over-capacity: it may well be that they will turn their attention to simplifying the production of a polyphonic synthesiser at some future date.

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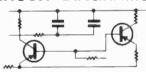
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frame, etc. Watch light rays bend as they pass through different ennes.

KA8 Water Pump Kit. Thirteen parts. Top of pump is transparent so that operating parts may be observed. Small parts are brightly coloured to be seen easily while working. Three types of pump may be made: Lift pump. Force Pump and Force Pump with reservoir and nozzle.

KA4 Burner Kit. Eleven parts. Transparent covers allow the operation of buzzer to be seen. Illustrates and teaches how electromagnetism with an automatic switch results in an operating buzzer.

KA6-2-Pole Motor Kit. Twenty-four parts including enamel wire, armature and pole piece, etc. Motor operates from 1 yoil battery. Illustrates and teaches how electro-magnetism operates a motor. a motor. 8P Change over spring return 250v 1 amp 10p

SP Change over spring return 250: 1 amp 109.

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Designing With

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BY A.FOORD

3 Basic Operational Amplifiers

An operational amplifier is essentially a high gain direct coupled amplifier which makes use of positive or negative feedback to control its overall characteristics. Originally the term operational amplifier denoted a circuit which performed a mathematical operation (such as, summation, differentiation, integration) in analogue computing. However, their applications are now extended to cover many fields; instrumentation and measurements are but two examples.

The required overall response of an operational amplifier is usually obtained by connecting feedback components externally from the output terminal back to the inputs. A differential input allows a considerable flexibility in the feedback configuration and also allows a reduction in d.c. drift because of the close matching of the input characteristics.

BASIC FORM

The basic form of the operational amplifier feedback circuit, illustrated in Fig. 3.1, shows that the voltage at the virtual earth (or summing point) is very small and tends to zero for an infinitely large amplifier gain.

For this type of circuit where the output is fed back towards the input in such a way as to reduce it, the overall characteristics become almost independent of A (the gain of the amplifier without feedback). The assumptions in the formula are that e is zero, no current flows into the amplifier terminals, and that A is much greater than G (the overall gain with feedback).

Summation of currents at the virtual earth point must always be zero. The overall gain is given by:

$$G = \frac{V_0}{V_i} = - \frac{R_2}{R_i}$$

The minus sign indicates a phase inversion.

Amplifiers of this type have a considerable isolation between input and output and many variations are

GLOSSARY

OPERATIONAL AMPLIFIER A low frequency amplifier, often used to perform mathematical operations.

DIFFERENTIAL INPUT An input applied between two input terminals.

VIRTUAL EARTH Low impedance signal point. **OFFSET ERRORS** Errors produced by voltage or current imbalance in the input stages.

COMMON MODE INPUT RANGE The maximum signal which can be applied simultaneously to both inputs.

possible. The input impedance is equal to R_1 . If R_1 equals R_2 the circuit gives unity gain where a sign change (inversion) is required.

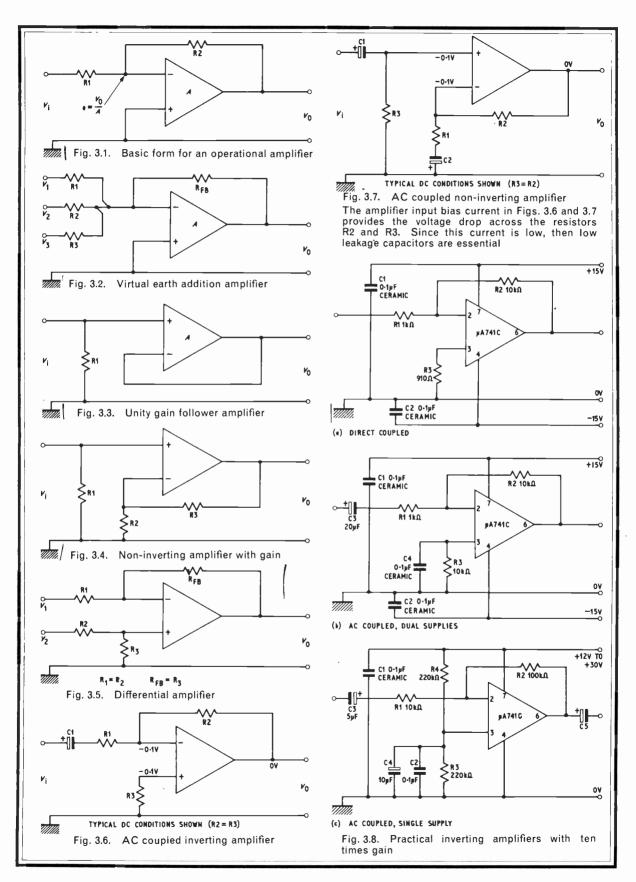
INVERTING AMPLIFIER AND ADDER

If a separate resistor is used for each input, as in Fig. 3.2, then current summing occurs at the virtual earth, with excellent isolation between inputs. For the first input the gain is

$$G=-\frac{R_{\rm FB}}{R_1}$$

Therefore

$$V_{0} = -\left\{ \left(\frac{R_{\text{FB}}}{R_{1}} \right) V_{1} + \left(\frac{R_{\text{FB}}}{R_{2}} \right) V_{2} + \left(\frac{R_{\text{FB}}}{R_{3}} \right) V_{3} + \dots \right\}$$



NON-INVERTING AMPLIFIER

For a non-inverting amplifier the input is connected to the non-inverting terminal of the i.c., while negative feedback is applied as shown in the diagrams. Feedback is now effectively in series with the input signal and care must be taken to make sure that the common mode input range of the amplifier is not exceeded.

A unity gain follower is shown in Fig.3.3 where all the output voltage is fed back in series with the input.

+ 15V **C1** 0-1 pF pA 741C R2 9k0 00 C2 0-1pF -154 (a) DIRECT COUPLED +15V 0-1pF **BA741C** R2 9kΩ 9kD. 1k O 20»F 0 0.1 »F -15 V (b) AC COUPLED, OUAL SUPPLIES 12V TO C1 ≷R4 220kΩ R3 R2 100kA 220kg (10kg .02 04 (c) AC COUPLED, SINGLE SUPPLY Fig. 3.9. Practical non-inverting amplifiers with ten times gain

This gives a high input impedance, a low output impedance, and unity gain. The non-inverting amplifier with gain (Fig. 3.4) also has a reasonably high input impedance. The gain for this arrangement is

$$G = \frac{R_2 + R_3}{R_2} = 1 + \frac{R_3}{R_2}$$

DIFFERENTIAL AMPLIFIER

The amplifier in Fig. 3.5 uses both inputs to amplify the difference between two signals. The gain can be equal to, greater than, or less than unity.

$$V_{\rm O} = \frac{R_{\rm FB}}{R_{\rm I}} (V_2 - V_{\rm I})$$

D.C. CONDITIONS

The amplifiers are designed to run from both positive and negative supplies with both input terminals and output terminal near earth potential (for a zero input signal) so that direct coupling can be used.

To maintain the correct d.c. conditions the amplifiers require a resistor from the output to the inverting input and a resistor from the non-inverting input to ground. Each input terminal should have the same d.c. source resistance to minimise the effects of input voltage and current offsets.

A.C. AMPLIFIERS

Although the amplifiers are basically designed for direct coupled use they are equally suitable for a.c. applications. In these cases d.c. blocking capacitors are used in the signal paths. When electrolytics are used, care must be taken with the d.c. biasing conditions since many circuits maintain little or no bias across the capacitors.

Low leakage tantalum capacitors are preferred, or two high grade electrolytics may be used back to back. This problem can sometimes be avoided by using a single supply rail.

For the inverting amplifier circuit of Fig. 3.6 the input impedance is equal to R_1 and the low frequency bandwidth is determined by R1 and C1. For the non-inverting amplifier in Fig. 3.7 the input impedance is approximately equal to R_3 .

PRACTICAL CIRCUITS

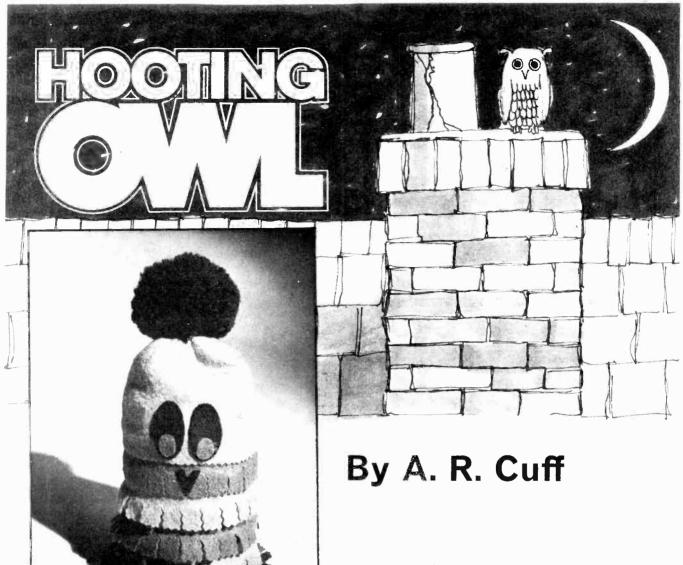
Some practical circuits for a.c. and d.c. use with a 741C integrated circuit (or equivalent) are shown in Figs. 3.8 and 3.9. The connections given are for the TO5 version. The ceramic decoupling capacitors should be connected as close to the integrated circuit as possible. The capacitors in the a.c. coupled circuits with dual supplies only have a small bias across them and should be tantalum types.

Next month: Part 4 looks at one of the most useful i.c.s, the Schmitt trigger.

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Simple to build and capable of endless variations, this toy will provide hours of amusement for children and adults alike.

This project describes some simple circuits for producing sounds which somewhat resemble the cries of small animals. It should interest readers who are looking for something amusing, which is easily constructed, and can be used to intrigue their friends.

The "owl" described here is just one of a large number of possible variations of the basic design and makes an ideal present for children or the girl friend.

Because the idea is so versatile it can be made simple for beginners or rather more complex for advanced constructors; in fact this is a very good first project as there are no problems with tolerances or setting up, and only the cheapest components need be used.

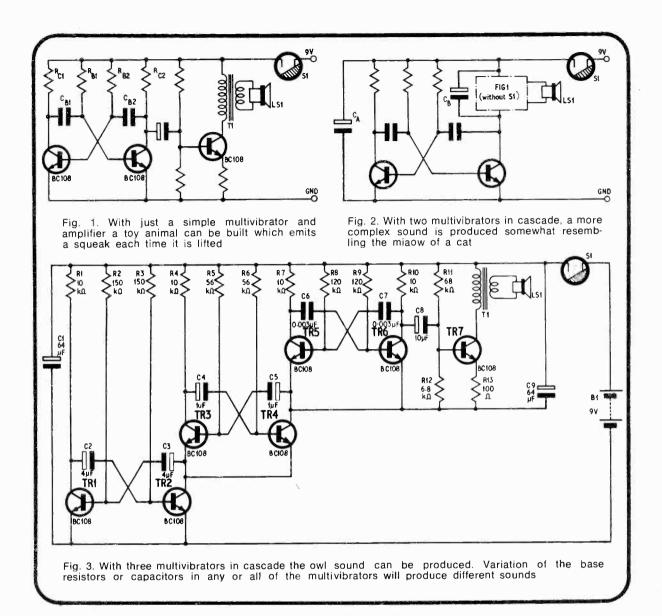
The finished animal can be made extremely attractive if a little care is taken with the external detail.

THE SIMPLE MODEL

The basic element in all the units is the astable multivibrator which is used in various combinations to produce a wide variety of animal and bird sounds.

In the simplest design as shown in Fig. 1 a single note astable is turned on and off by a mercury switch. The mercury switch (for those who have not encountered them before) is a sealed tube containing mercury which is free to move about. Two contacts sealed into the glass form a switch which is only closed when the mercury covers both. Thus when this switch is used in the model animal it can be arranged so that the animal only emits a noise when tilted.

Also shown in Fig. 1 is a capacitively-coupled single-transistor amplifier to provide sufficient volume to operate a small 8 ohm speaker, and also to avoid excessive loading of the oscillator.



Thus the creature remains silent until picked up when it mysteriously squeaks!

MULTIVIBRATOR DESIGN

In order to successfully design the astable of Fig. 1, two important points must be kept in mind. Firstly, that the frequency of the oscillation is given by the expression

$$f(Hz) = \frac{1}{0.69(R_{B1} \times C_{B1} + R_{B2} \times C_{B2})}$$

so that the approximate frequency must be decided before construction is started (1kHz gives a pleasing tone)

Secondly, to ensure oscillation the value of the base resistors must be small enough to provide sufficient base current to cause saturation of their respective transistors.

This can be written as $R_B
leq h_{FE} \times R_C$ where h_{FE} is the current gain of the transistor.

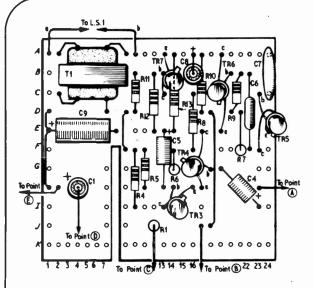
However, since most constructors will be unable to measure the current gain it is safer to ensure that the base resistors are not more than 10 to 15 times the value of the collector resistors, especially if unmarked transistors are to be used. Thus if $R_{\rm C}$ is 10 kilohms then $R_{\rm B}$ should not exceed 150 kilohms.

For the sake of simplicity the base resistors are made equal in this circuit.

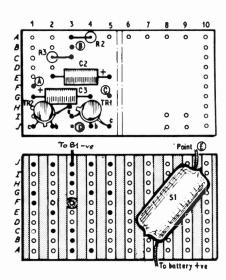
ADDING SOPHISTICATION

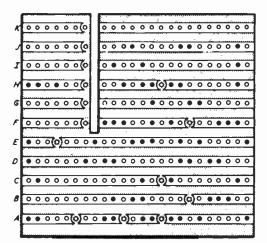
The next step to improve the sound effect is to add a second astable as shown in Fig. 2.

In this version the entire circuit of Fig. 1 is used as the collector load for another, slower astable. The frequency at which this circuit oscillates can be varied from about 1Hz to approximately half the



15







COMPONENTS . . .

Resistors

R1 $10k\Omega$ R2, R3 150k Ω (2 off) R4 $10k\Omega$ R5, R6 56kΩ (2 off) R7 10kΩ R8, R9 120kΩ (2 off) R10 $10k\Omega$ R11 $68k\Omega$ R12 6.8kΩ R13 100Ω All ¼W ± 10% carbon

Capacitors

C1 $64\mu\text{F}$ 10V elect. C2, C3 $4\mu\text{F}$ 10V elect. (2 off) C4, C5 $1\mu\text{F}$ 10V elect. (2 off) C6, C7 $0.003\mu\text{F}$ (2 off) C8 $10\mu\text{F}$ 10V elect. C9 $64\mu\text{F}$ 10V elect.

Transistors

TR1-7 BC108 or similar (7 off)

Transformer

T1 Transistor audio output transformer (Eagle LT700 or similar)

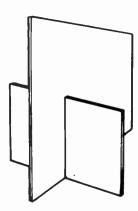
Switch

S1 Mercury switch

Miscellaneous

LS1 2¾in 8Ω speaker B1 9V battery type PP3

0.1in matrix Veroboard, custard tin (or similar), felt or other suitable material for decoration



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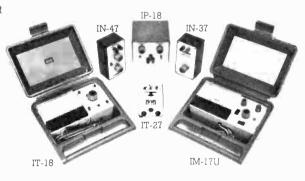
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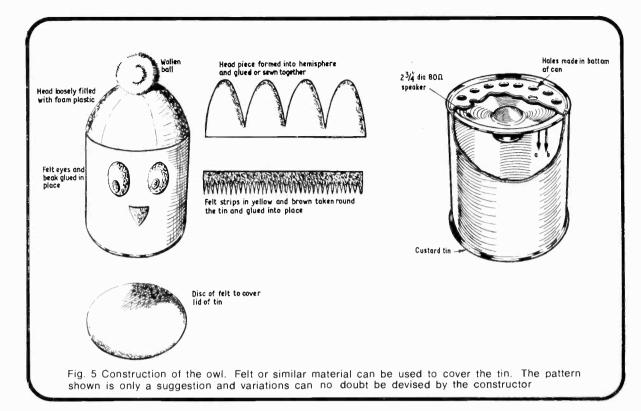
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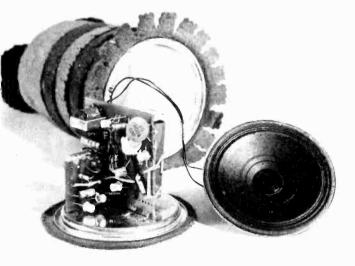
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frequency of the first to provide some very interesting effects. At low frequencies the "squeak" is switched on and off and sounds something like a cat miaowing, at higher frequencies a warbling sound is produced.

In the prototype the addition of capacitors CA and CB of 100 nF each was found to reduce the sharpness with which the circuit switched, and also enhanced the sound considerably. Of course the value of the capacitors is open to experiment.



HOOTING OWL CIRCUIT

By cascading astables as in Fig. 3, each time building on the existing circuit with a slower astable, very complex sounds can be made which are slow to repeat themselves exactly. (For more than three stages a higher battery voltage may be required.)

The circuit shown produces a sound somewhat like an owl, though other sounds can easily be made by changing the values of the capacitors in any or all of the astables.

A final point to remember when cascading stages is to ensure that each new stage can supply sufficient current to the existing stages. This means keeping the value of the base resistors as low as possible, in accordance with the desired frequency.

CONSTRUCTION

The scope for a suitable "carcass" is limitless, anything with sufficient space for the speaker and electronics will do. An ordinary 11oz size custard tin was found to be ideal for the owl.

First punch some holes in the metal end of the tin, and glue or solder the speaker in place (see Fig. 5). The circuitry is then built on Veroboard (Fig. 4) and soldered to the lid.

This method of construction allows sufficient room for the PP3 battery and the mercury switch as well as making access easy for battery replacement. The lid is just pushed home to seal the unit.

The outside of the tin can be disguised by using strips of coloured felt (see Fig. 5) and a very attractive finish can be obtained in a matter of an hour or

When completed the owl stands upright and is switched off for convenience. The mercury switch can be arranged to close at any desired angle to activate the device.

ELECTRONIC PIANO

Part 4

By A. J. Boothman B.Sc.



AST month the construction of the basic pitch p.c.b. was described of which 13 are required. To test these and to compensate for possible variations in output from the logic circuits, it is desirable to make up a simple jig. Such a construction also facilitates choice of tuning capacitors for the Hartley oscillator.

PITCH BOARD TEST JIG

The jig consists simply of a one foot square piece of wood to the edge of which is screwed two terminal blocks; one three-way and the other two-way.

The first block (3-way) connects to $V_{\rm s}$, earth, and the pre-amp output on the pitch board under test, whilst the second block (2-way) anchors two floating leads at supply voltage. Response to keying action is checked by touching one of the floating leads against a key input pin on the pitchboard, whilst the other lead can be used to check the sustain action. See Fig. 4.1.

In order to ease the handling of the pitch boards during initial alignment, and to minimise the possibility of damage due to careless short circuiting of supply leads, etc. it is recommended that the p.c.b. frame is first built prior to any alignment.

P.C.B. FRAME

Fig. 4.2 shows the method of construction of the frame. If the final mechanics of the piano are to fit together satisfactorily it is important that this is assembled with care to ensure squareness. To ease this problem it is suggested that screws alone are used at this stage and that the glueing process is left until later when the rest of the mechanics has been built.

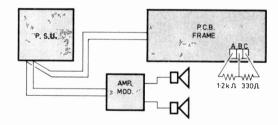
WIRING THE FRAME BLOCKS

The rear connector blocks, which have been cut into groups of three, carry the positive rail (V_s) , pitch output, and earth line. The pre-amplifier/tremolo board is screwed onto the frame and panel, with the level tremolo depth and rate potentiometer spindles protruding from the frame side.

An eight-terminal connector is fixed to the bottom front bar at the right-hand side to provide the connections between the pre-amplifier board and other functions of the piano. Red, blue and black wires for supply $(V_{\rm s})$, pitch output and earth return are connected to each rear terminal block. From the last block this wiring is made to terminate at the pre-amplifier/tremolo board.

The black and blue terminations are shown as a screened lead on the pre-amplifier board layout shown earlier in Fig. 2.7, but this is not necessary provided that the leads between the last connector block and pre-amplifier board are kept as short as possible. The red and black leads are left long at the opposite end of the module in order to provide connections to the power supply.

The eight-terminal block takes leads shown in Fig. 2.7 as follows. The red and orange, that will finally connect to S3; the green, blue and red to S2; and the screened lead to the main amplifier.



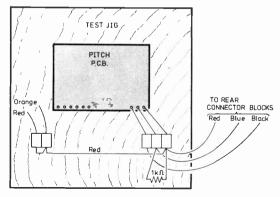


Fig. 4.1. Test set-up for individual pitch p.c.b.s

TEST SET UP

With the pitch p.c.b. module completed as above the initial setting up is almost ready to commence.

Fig. 4.1 shows the interconnection of the various units to give a test and initial setting up arrangement for the pitch boards. In order to make the system operational certain components have to be added during the test phase as follows.

Since the foot and keyboard level controls have not yet been constructed they must be simulated by soldering a short jumper between the VR3 red and yellow wiring pins on the pre-amplifier board (Fig. 2.7), and inserting two resistors in the terminal strips corresponding to S2 connections A-B and B-C. The resistor values should be $1.2k\Omega$ and 330Ω respectively.

As we are to test one pitch board at a time, the output load condition will be very different to the final situation when all boards are connected up so a 1k\Omega resistor is connected across the blue and black connections on the test jig terminal block.

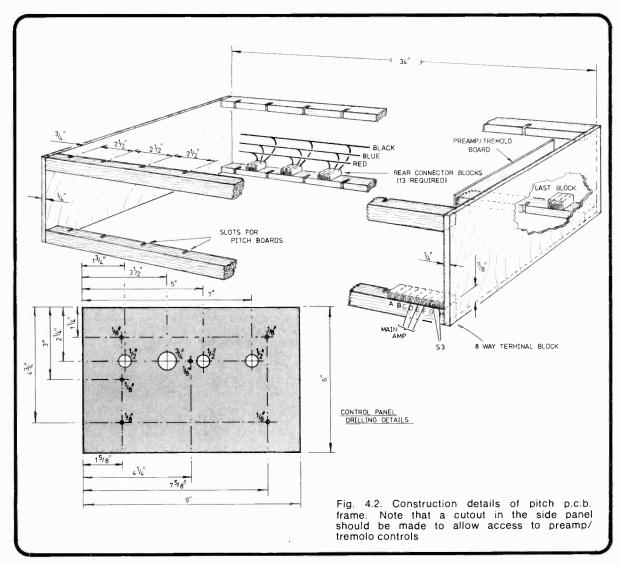
From this point on the constructor could well be involved in a considerable amount of board removal and re-insertion, requiring repeated screwing and unscrewing on the connector strips. It is strongly recommended that a good screwdriver be purchased for this purpose, and further that it should be the correct length for easy operation from above the pitch p.c.b. module.

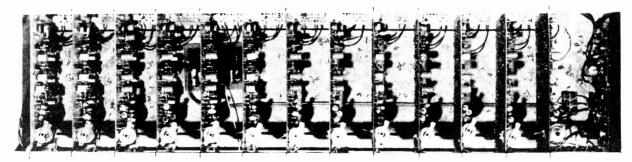
INITIAL SETTING UP

The purpose of the initial setting up procedure breaks down into the following:—

- (a) Determine whether any catastrophic shorts are present on any of the assembled pitch boards. Also make sure correct fuses are inserted in FS1 and FS2 positions.
- (b) Determine whether any mistakes have been made during board assembly, e.g. diodes connected the wrong way round.
- (c) Correct for any large variations in logic output if necessary.
- (d) Correct for any large variations in individual note outputs due to transistor gain spreads if necessary.

In order to approach the operation systematically, the key touch sensitivity is not involved at this stage





The thirteen pitch boards mounted in the wooden sub-frame

so that an acceptable balance is first achieved without the confusing element of touch variation.

TEST PROCEDURE

A board is first wired up to the test jig, with an $0.1\mu\text{F}$ or $0.2\mu\text{F}$ capacitor in position C48. On switching on the power, providing that everything is reasonably correct, a mixture of all the octaves of the note in question will be heard as a background noise.

Touching the test lead against any of the five key input terminals should cause the relevant note to trigger, and sustain in a fading manner for the period the test lead is held against the pin. Decay should be immediate on removal of the test lead, and it should be possible to simulate unkeyed sustain by connecting the second test lead to the sustain pin.

If, against the background noise, any particular note appears to be dominant, it may be desirable to reduce its level at this point. However some breakthrough will always occur, and the importance of this seems to diminish when the instrument is complete. It is therefore recommended that adjustments only be made if a note is extremely dominant, and the final decision as to the amount of time spent in this activity left until everything is built.

One point to remember here is that bass response is bound to be very low with the speakers mounted in this test arrangement with no cabinet resonance.

In order to adjust the breakthrough level on any particular note the value of R74 (or 75/76/77/78) is varied.

This is best carried out by soldering a second resistor across the $5.6k\Omega$ original to reduce its composite value, and thus reduce the signal to the relevant mixer. Convenient values to be tried are $56k\Omega$, $27k\Omega$ or $10k\Omega$.

Should any note require a higher output then a bridging resistor across R84 (85/86/87/88) can be used. When all the boards have been checked in this way they can be slotted into the pitch board module, and the 1k\Omega resistor removed from the test jig. Tuning (and C48 selection) could be attempted at this point, but since this is done by ear it would be very difficult without the keyboard for easy interval reference.

TUNING CAPACITOR

Capacitor C48 in the oscillator circuit is composed of a number of capacitors connected in parallel and whose values are chosen to give the required pitch at the central position of adjustment on the tuning inductor. The range of capacitance required is approximately $0.1\mu F$ to $0.4\mu F$, and the selection process is carried out using the board test jig described earlier. The table gives suggested capacitor values with which to make the composite capacitor C48, but since winding the inductors by hand can result in quite a spread in inductance values, the capacitor values given should only be considered as a rough guide.

Table 1: Approximate capacity values for tuning pitch p.c.b.s

		Tuning	Added
Pitch	Frequency	(Hz) Capacitor (C48)	Capacity (μF
F	700	0.33	
F#	740	0.22	0.057
G	784	0.22	0.022
ΑЬ	830	0.22	_
Α	880	0.1	0.1
Вь	932	0⋅1	0.069
В	988	0.1	0.047
С	1047	0.1	0.033
C#	1109	0.1	0.015
D	1174	0.1	
Еb	1245	0.047	0.043
Έ	1319	0.047	0.032
F	1397	0.047	0.022

PEDAL SOCKET BOARD

Figs. 4.3 and 4.4 show the circuits for the sustain and soft pedal sockets respectively. All components are mounted on the pedal socket p.c.b. The sustain voltage is dropped below V_s by Zener diode D34. This gives a sharper fall in voltage when a key is released with the sustain pedal depressed, such that rapid playing of a single note in the sustained mode produces a noticeable attack each time the note is pressed. Capacitor C51 prevents switching noise.

The soft pedal is simply a potentiometer, but R124 is connected on the p.c.b. as shown in order to present a similar load to the pre-amplifier when the soft pedal is disconnected. The piano can be played in this condition, and also with the sustain pedal unplugged. The jack socket is a stereo type in order to handle the three wires from the potentiometer.

In order to allow the pedals to be disconnected

from the instrument and packed away whilst being carried, they are connected to the piano by two screened leads and jack plugs. Mating sockets are mounted on a printed circuit board which is screwed to the base inside the piano, with suitable holes drilled in the base board to allow the plugs to pass through. See Fig. 4.5.

When the pedal p.c.b. is later fixed to the base board, supply leads are taken from the pitch board frame, and the sustain output is connected to the nearest sustain point on the key frame assembly. The soft pedal socket is connected via screen leads to the pre-amplifier board. These are the green, yellow and red leads shown in Fig. 2.7 (part two), which should in fact be screened.

PEDAL SHELL DETAILS

The outer construction is common for both pedals, and consists of a shaped $\frac{1}{4}$ in plywood box, with an extra $\frac{1}{4}$ in strip at the front to act as a platform for the hinge. Fig. 4.6 shows the complete shell, including the $\frac{1}{4}$ in plywood flap.

The shell should be fixed together using a good grade of wood glue, and panel pins. The final assembly can be painted or covered in a fabric, with rubber foot and base pads.

SOFT PEDAL DETAIL

There are many ways in which the action could be constructed, and the author would expect many builders to choose to use an alternative method to that described here.

The important fundamental is that pressure should not be exerted on the potentiometer spindle against the body either in a rotational sense or at right

SUSTAIN PEDAL

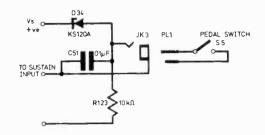


Fig. 4.3. Circuit diagram for the sustain pedal

SOFT PEDAL

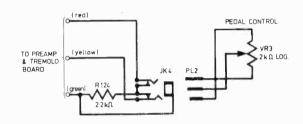


Fig. 4.4. Circuit diagram for the soft pedal

COMPONENTS . . .

Resistors

R123 10kΩ R124 2·2kΩ

R125 $3.9k\Omega$ All resistors \pm 5% $\frac{1}{4}$ watt

Capacitors

C51 0·1μF 125V

Switches

S5 Single pole microswitch

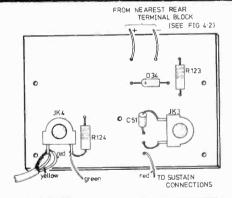
S6 Single pole, 5-way rotary switch

Diodes

D34 12V 400mW Zener diode D35-D40 ZS170 (6 off)

Miscellaneous

JK3—Standard jack socket. JK4—Stereo jack socket. PL1—Standard jack plug. PL2—Stereo jack socket, knobs for keyboard control (4 off) (Bulgin)



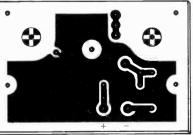
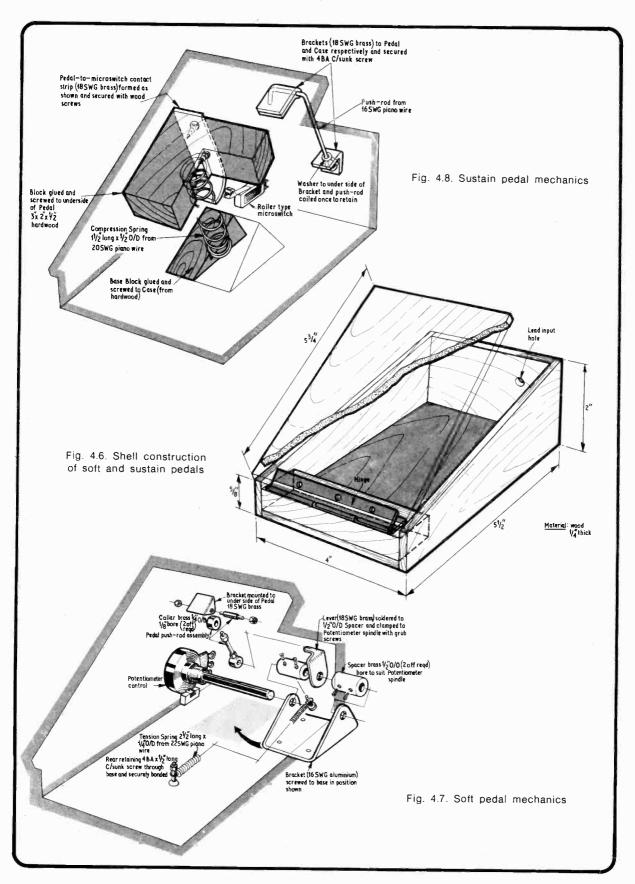


Fig. 4.5. Component layout and printed circuit details for pedal socket p.c.b.



MATERIALS LIST FOR FOOT PEDALS

Shell Construction (Two Required)

5½in × 2in × ¼in plywood	(2 off)
$5\frac{1}{2}$ in $\times 3\frac{1}{2}$ in $\times \frac{1}{4}$ in plywood	(base)
$3\frac{1}{4}$ in $\times 1\frac{3}{4}$ in $\times \frac{1}{4}$ in plywood	(end plate)
$3\frac{7}{4}$ in $\times \frac{3}{4}$ in $\times \frac{7}{4}$ in plywood	(hinge platform)
$5\frac{3}{4}$ in \times 4in \times 4in plywood	(top flap)
3in hinge	

Soft Pedal Detail

2½in × ¼in dia, tension spring
3in × ⅓in dia, wire
3½in × 2¼in × ⅓in aluminium sheet
¼in brass spindle coupling
Screws, spacers, and cable cleats as required

Sustain Pedal Detail

1½in × ½in dia. compressing spring
3in × ⅓in dia. wire
1¾in × ½in × 1⅓in aluminium sheet (switch actuator)
1¼in × ½in × 1⅓in aluminium sheet (retaining bottom bracket for wire)
Screws, spacers, and cable cleats as required.

angles to the axis. The action should therefore only be built around the spindle, without clamping the body, but it is obviously necessary to provide a stop with which to prevent the body rotating.

Fig. 4.7 shows a possible solution. Lateral movement is prevented by positioning the support in such a position that the potentiometer body rests up against the shell side, whilst a small piece of wooden channel fixed to the base prevents rotating movement of the body. If brass bushes can be obtained, instead of relying on ¼in holes in the aluminium, the action will be smoother.

The ¼in spindle coupler is slipped over the spindle and secured with one screw, which also acts as a stop in the pedal off position. A further screw, with suitable spacer gives a lever on which to mount one of the cable cleats which acts as a bearing for the bent wire. The second cleat is fixed to the flap, and can be removed when access to the mechanics is required after the initial build.

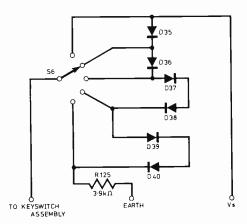
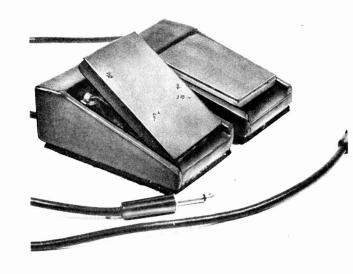


Fig. 4.9. Touch control circuit



The two prototype foot pedals

SUSTAIN PEDAL

The same comments apply concerning alternative sustain pedal mechanics as for the soft pedal control. In the prototype the author used a commercial footswitch, but details of a suggested assembly are given in Fig. 4.8.

A ½in diameter compression spring provides the power to return the pedal after operation, and the upward travel is limited by a wire shaped to be captive in the top bearing (cable cleat), and retained within a slotted hole in the lower bracket. Access to the internal mechanics is again achieved by disconnecting the top bearing from the flap. The spring is seated within ½in diameter holes drilled in packing pieces which are attached to the flap and to the base.

Depending on the microswitch obtained a number of alternative configurations might be used.

TOUCH CONTROL

The touch control is mounted to the left of the keyboard, and gives preset selection of the maximum attack required at any particular time. The keyboard actuated touch sensitivity allows the player to reduce the attack below this maximum preset level by finger tip control.

The present variation in attack is achieved by controlling the voltage at the keyboard as seen in Fig. 4.9. Diodes D35-D40 give a range of attack voltages to suit the player. All diodes are mounted on the switch, which also has flying leads.

LEVEL CONTROL

This acts as a stepped potentiometer which allows rapid changes to be made in the playing volume. The resistors are mounted on the switch S2, as shown in Fig. 2.4. Normal playing position is position 2.

Nextmonth: Keyboard, keyswitch assembly and cabinet details will be given.

FIFTY YEARS OF BROADCASTING

continued from page 1017

Two major technical developments, each to have profound effect upon the social habits of millions, are part of the exciting BBC story. They are television and recording.

A late entrant into the field of sound broadcasting, Britain was to become first in the field of television. The all-electronic high-definition system developed by E.M.I. was adopted by the BBC when it commenced a regular television service in 1936, thus antedating the start of television in the U.S. by three years. So public service broadcasting stole a march on commercially-run broadcasting. This pioneering achievement demonstrated very forcibly the strength of a combination formed of a free enterprise industrial concern and a national institution devoted to public service, when working together with a definite objective in view.

Recording has greatly influenced the pattern of broadcasting in recent times. In its earliest years the BBC made limited and cautious use of recorded sound (as distinct from commercial discs) although a Blattnerphone steel tape recording machine was installed at Savoy Hill as early as 1931. Apart from the imperfection of the techniques then available opposition to the use of recorded material was based on a strongly held view that actuality was the very essence of broadcasting. However romantic such a view may seem to blasé listeners of today, most listeners of the 20's and 30's agreed that the direct and immediate reception of events as they were happening was one of the unique enchantments of the new "wireless" entertainment.

Today's prodigious output of sound and television owes very much to the great advances made in the audio and video recording techniques, notably due to contributions by commercial firms in Germany and U.S. All those hours of broadcasting we have become accustomed to can only be sustained with the aid of a stock of "convenience programmes" stored on disc or tape. With the insistent demand by the public for more broadcasting the "live" element is diminishing and thus the character of broadcasting is changing. There is a danger that broadcasting organisations will become merely carriers of other peoples' canned wares. (The automated sound broadcasting station with built-in magazines of audio tapes is already available as a "packaged deal." How long before the television counterpart makes its debut?)

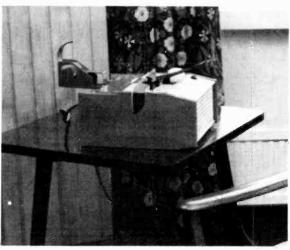
This tendency will be accelerated with the introduction of commercial local radio next year, and with the possible granting of a second television channel to IBA. There is every reason therefore to ensure we preserve in its existing form our first and most experienced national broadcasting organisation with its unrivalled artistic production facilities that complement a justly renowned technical organisation. And champions of public service broadcasting do need to be vigilant. In anticipation of the expiry of the BBC's Charter and the Television Act in 1976, the pattern broadcasting will follow in the future is already undergoing careful examination.

F.E.B.

NEWS BRIEFS

Talking Book Library for Handicapped

A NATIONAL library has been established to help the many disabled people who are unable to read books in the normal manner. It is a library of talking books covering a wide range of subjects, all on purpose-made tape-cartridges containing up to 13 hours of reading.



The National Library of Talking Books is a registered charity and following a successful pilot scheme it already has a readership of 500 disabled people. It is hoped that Local Authorities and organisations for the handicapped will co-operate so that the talking books and playback machines may be made freely available to those in need. Further inquiries should be made to the National Library of Talking Books for the Handicapped, 49 Great Cumberland Place, London WIH 71 H

Novel Educational Aid

A N EDUCATIONAL aid with a wide range of applications has just been introduced by Palca and is being distributed by Dixons Technical. Known as the Wireless Headphones System it makes use of a long loop of flex which surrounds an area within which communication is to take place. Anyone inside the loop and equipped with the special headphones, which are, in effect, self-contained receiver amplifiers, will hear the signal fed into the loop.

The loop acts as an indication loop aerial and its size can be extended to the requirements of the user. For instance it could surround a factory floor so that orders can be given in a noisy environment, or it could be used in a classroom with small groups of desks connected to different sources so that a number of lessons can carry on in the same room. Because the headphones are self-contained the wearer has complete freedom of movement allowing the system to be used for such applications as relaying information to footballers while the players are in motion.

The headsets cost only £7.50 each and the loop connector an extra £2 so making this a worthwhile and economic proposition.

Further inquiries should be addressed to Audio Visual Division, Dixons Technical Ltd., 3 Soho Square, London W1V 5DE.

PATENTS BEVIEW...

CHECKING ENGINE IGNITION

The conventional way of checking ignition advance and engine speed is to use stroboscopic illumination of a timing mark on an engine part, such as the flywheel, the stroboscope being triggered by the lead to a sparking plug.

In BP1 273 496 Snap-On Tools Corporation of Delaware, USA, suggests a more sophisticated

approach.

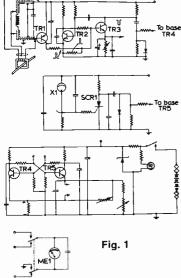
Their system relies on a meter with a dial calibrated to show both engine and distributor advance in degrees and engine and distributor

speed in r.p.m.

Instead of using a stroboscope to illuminate the timing mark, the mark is covered with a small strip of reflective tape and is illuminated by a sensing device housing a lamp and a photocell. During operation the lamp is energised continuously and the light from it picked up by the photocell only when reflected back from the reflective tape over the timing mark. This produces a series of voltage pulses and the patent describes circuitry for comparing this series if pulses with another series of pulses obtained from inductive coupling with a spark plug lead (ignition pulses).

Fig. 1 shows how the spark plug voltage pulses are fed, via amplifier transistor TR1, to a one-shot multivibrator (transistors TR2 and TR3). The pulses from the photo-

BP 1 273 496



cell XI are used to control the thyristor SCR1. A train of pulses triggered by the spark pluq pulses are fed to the base of TR4, while another train of pulses triggered by the photocell are fed to the base of TR5. The meter ME1 measures the time interval relative to engine period between successive pulses of the two pulse trains and converts this time interval into a direct read-out of degrees of engine or distributor rotation.

As engine timing is automatically advanced with increasing engine speed, the time interval between successive pulses becomes longer relative to rotation time and produces a higher reading in degrees on the meter. By reading the ignition advance in degrees for a series of engine speeds and checking against those recommended by the manufacturer, the engine can be subjected to rigorous testing.

WHEEL SPIN CORRECTION

Westinghouse Brake & Signal Co. Ltd., have patented (BP 1 277 474) some circuitry for use in testing devices for correcting spin or slide of a vehicle wheel.

These devices usually rely on deriving a rate of change of velocity signal depending upon the rate of change of the peripheral speed of the vehicle wheel. A modification circuit responds to a preselected value of this signal (indicative of the tendency of the wheel to spin or slide) and so modifies the braking forces.

A problem with such systems is that they are hard to check when stationary in a garage and the preselected signal values are hard to set. The Westinghouse invention attempts to tackle this problem.

The oscillator section of the patent is shown in Fig. 1. The unijunction transistor TR1 has b, base connected via R2 to the junction of R1 and Zener Diode D1. R1 and D1 are connected across a 30V supply and b, base is connected via R3 and the primary winding of T1 to the supply negative line.

The transformer T1 is part of a test device coupled through the secondary winding to a generator which produces a signal of which the frequency is proportional to the peripheral velocity of the vehicle wheel.

The emitter of TR1 is connected to the junction of diode D2 and capacitor C1, the other side of D2 being connected via R4 to one

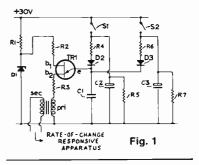
side of switch S1. Capacitor C2 bridges R4, D2, C1 and is itself bridged by a discharge resistor R5. An exactly similar arrangement of components is made between TR1 emitter and switch S2 with R7 acting as the discharge resistor.

As mentioned above, the secondary winding of T1 is connected to the wheel generator of a spin or slide detection apparatus, the generator providing signals for the detection apparatus and the latter responding to a predetermined rate of change of peripheral wheel speed to initiate modification of braking.

As a service check a mechanic operates switches S1 and S2 to produce oscillations and inject them into the secondary winding.

Closing S1 causes oscillation by alternate charging of capacitor C1 via D2 up to a point at which the transistor conducts C1 and discharges C1 via the emitter and b₂ base of TR1 into the primary winding of T1. The frequency initially depends on supply voltage, and in release of S1 changes at a rate dependent upon the rate of change of voltage applied to the emitter electrode of TR1 via C2. This is in turn dependent upon the discharge rate of C2 via R5. R5 is chosen to give a rate of change after release of S1 which corresponds to the minimum rate of change of speed of the wheel

BP 1 277 474



Closure of S2 produces similar results but R7 is chosen such that the rate of change of frequency corresponds to a rate of wheel speed change to which the braking control is not required to respond.

Flipping switch S1 should trigger the modification circuit and flipping of S2 should not trigger the modification circuit. If the mechanic finds this is not the case, then adjustment of the sensing and braking equipment is called for.



Substitutes for VARACTOR DIODES By B. Fistein

A REVERSE biased semiconductor diode has a high d.c. resistance. This is caused by the fact that the reverse voltage applied attracts current carriers (holes and electrons, in p- and n-type semiconductors respectively) away from the junction, leaving a region near the junction depleted of holes and electrons, called the "depletion layer". The greater the applied reverse voltage, the wider is the depletion layer.

Since the portions that are not depleted of carriers have a low ohmic resistance, a reverse-biased pn junction behaves as a capacitor in which the electrodes (i.e. the non-depleted regions) are separated by a thickness of dielectric (i.e. the depletion layer). The thickness of the dielectric, and hence the capacitance, can be varied by varying the reverse voltage applied.

The same principles apply to all semiconductor pn junctions and, in particular, pn junctions in transistors. Thus reverse biased junctions in transistors may be used as variable capacitors by varying the applied voltage.

Silicon transistors are particularly suitable for such use, as currents across their junctions when reverse biased are very small, resulting in a capacitance effect of very low leakage. Bias voltages that can be applied to vary the capacitance, range from a small fraction of a volt to a maximum which is the break-down (Zener) voltage of the junction.

The a.c. voltage applied to the variable capacitor, however, must be a small fraction of the bias voltage, otherwise detuning and the generation of harmonics will result.

TEST CIRCUIT

The circuit used for measuring the capacitance at different collector-base voltages is shown in Fig. 1. The inductance L1 is of known value. A reverse voltage is applied to the junction under test through the potentiometer VR1, and the resonant frequency of the circuit is determined by means of a grid-dip meter. A low impedance path for a.c. is provided by capacitor C1 to the potentiometer wiper.

A number of transistors were tried. Plastic planar transistors appear to function best. Transistors encapsulated in TO5 or TO18 style metal cans had higher capacitances than plastic ones, although the ratio of maximum to minimum capacitance was much the same for both types.

Fig. 2 shows capacitances for applied voltages between 0·15 and 12 in transistors of three different types. There was some variation among transistors of the same type, but most transistors tested showed a ratio of maximum to minimum capacitance of about 5:1. The greatest change in capacitance occurred at low voltages.

Within the limitations mentioned these transistors functioned satisfactorally as tuning capacitors for frequencies up to 20 MHz or higher, and with reasonable care in the layout of circuits, the highest frequency tuned with a given inductance was generally a little more than twice the lowest.

RECEIVER APPLICATION

The possible uses of voltage dependent capacitors are many, and include tuning, automatic frequency control, generation of harmonics, and others. As an illustration of the use of a transistor as a tuning capacitor, one was used in a simple reflex receiver for the medium wave band.

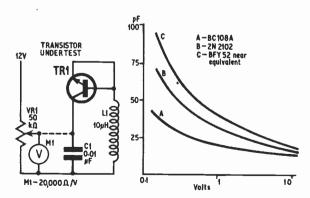


Fig. 1. (left). Circuit used to determine capacitance of a collector-base junction

Fig. 2. (right). The resultant voltage/capacitance characteristic of three sample transistors

The transistor used as a variable capacitor is TR1, in this case, type BC108. The variable voltage applied to it is obtained from the potentiometer VR1; as most of the change in capacitance occurs at low voltages, VR1 should be a logarithmic type. Since the capacitance (and hence the tuned frequency) depends on the applied voltage, the power supply to the receiver should be stabilised by means of a Zener diode.

The inductor L1 used for tuning consists of 200 turns of 36 s.w.g. enamelled wire, close-wound on a ferrite rod \(\frac{2}{3}\) in diameter and 3in long. The secondary winding L2 consists of eight turns wound over the "earthy" end of L1, and wound in the opposite sense. The regeneration capacitor, C2 consists of two short lengths of thin p.v.c. insulated wire twisted together.

TUNED CIRCUIT

Because of the small tuning capacitances and relatively high inductance used in tuning, C2 is connected to a tap on L1, 40 turns from the earthy end, rather than to the "live" end as usually done in receivers of this type.

in receivers of this type.

Alternatively, C2 may consist of a short length of p.v.c. insulated wire; one end is connected to the collector of TR2, the other end is bent to fit snugly over L1 for one half turn. This half turn is moved along the length of L1 until optimum regeneration without oscillation is obtained over the whole tuning range, and is then fixed to L1 in that position.

With reasonable care in the lay-out of components associated with TR1 and TR2 the receiver will tune over the greater part of the medium wave band. VR1 may be placed where convenient, preferably well away from L1 to reduce detuning by hand capacitance while operating it. L3 should not be close to L1, and the axes of these inductances should be at right-angles to each other to avoid mutual coupling between them. Audio output is taken from C5 to high impedance headphones, or to an audio amplifier for loudspeaker operation.

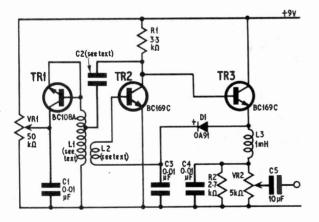


Fig. 3. An example of the practical application of the junction capacitance of a transistor. In this simple reflex receiver the "varactor" effect is achieved by feeding a preset voltage to the collector-base junction of TR1

NEXT MONTH....

A new area of interest, demonstrating how organic living systems and electronic systems can interact, is opened up with the publication next month of design and application data for a

Biological Amplifier

for detecting very low frequency signals produced by the brain.

In conjunction with various output stages, this amplifier can be safely employed for specific non-medical purposes: as an alphaphone to induce relaxation, with aural feedback between the brain and ear; or as a cardiophone where control of the heart rate is achieved by means of a visual feedback loop.



IC Linear Ohmmeter

Conventional ohmmeters have non-linear scales which, though providing large ohmic ranges, are difficult to interpolate and require special meter calibration. The I.C. linear ohmmeter gets round these difficulties using a cheap milliamp meter to provide three resistance ranges from 0-100k Ω .

ELECTRONICS

January issue on sale December 8

Ensure your copy by ordering in advance from your newsagent.

ELECTRONORAMA

AIDS TO MOTORING SAFETY

The problems of traffic control and collision avoidance on the world's roads has long been a problem that many countries have been seeking to find a satisfactory solution. Two companies, in the U.K. and America, have been developing separate systems, both based on the principles of radar, to help combat the problems of safety on the roads. The great advantage of using radar is that it is able to penetrate fog.

At the moment these systems are still in the experimental stages but both RCA and Mullard, the

developers, hold great hope for the future.

Radar "Cat's Eyes"

A traffic sensor has been devised at the Mullard Research Laboratories in Surrey, which could form part of a fully automatic system to control traffic, unaided

by a human observer of traffic conditions.

One of the problems encountered with most radar traffic control systems has been that if more than one vehicle is in the beam it tends to confuse the equipment. But with the Mullard system the sensor device is very similar to the modern "cat's eyes" and is installed in the road in the centre of each lane. This way only the car passing directly over the sensor is detected.

The sensor device is a compact radar unit containing the transmitting aerial and receiving aerial and, as the cars passing overhead are detected, a second set of detectors activate circuits which measure the speeds of

receding vehicles.

In a complete system, data derived from the radar "cat's eyes" installed in roads at strategic places would be routed to a central computer which would analyse the total traffic situation and control roadside warning lights and junction traffic lights accordingly.

Anti-collision radar

The RCA experimental auto radar system is designed to avoid rear-end collisions on the roads and help drivers to maintain reasonably safe distances between the car and the vehicle in front.

A feature of the system is its ability to eliminate false "targets" and "clutter". It is not "blinded" by

Tests being carried out on the RCA system. The radar units can be seen on the two cars, just above and below the licence plates





Artist's impression of how one of the traffic sensors, being developed by Mullard, would be installed in the road surface.

the radar signals of vehicles passing in either direction in adjacent lanes. The radar beam is narrow enough to avoid unwanted reflection when a car moves out into another lane to pass a car ahead. Consequently, the car can pass without a warning being sounded.

The compact radar, mounted on the front of a car, transmits a continuous 9GHz (X-band) signal which strikes the passive harmonic reflector on the obstacle ahead. This reflector re-radiates the second harmonic (18GHz) of the incident signal. The radar receiver is designed to accept only those radar echoes that are double the frequency of the

transmitted signal.

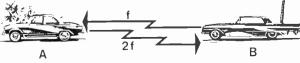
The reflector is approximately the size of a number plate and can be affixed to the rear of any vehicle or to any sign designating a traffic hazard. By using this special reflector all vehicles and traffic hazard signs, no matter what size, provide the same reflected signal strength. Thus a small car or a "one-way-do-not-enter" sign will be picked up by the radar system as clearly as a large container lorry, and their radar echoes will not be swamped by the echoes of larger vehicles.

Eventually, it is hoped, an operational radar of this type might be integrated into a car so that it would automatically release the throttle and apply the brakes to keep distances between vehicles above a safe minimum. Furthermore, if special small reflectors were incorporated on the sides of motorways and on collision hazards such as bridges, the radar could automatically apply the brakes if the vehicle is approaching the

hazards at an unsafe speed.

The RCA system still requires testing and refinement, but scientists believe that an operational system can be mass produced within five years

Showing how the RCA system works. Radar on car B transmits a signal (f) which is reflected back at twice the frequency (2f) by a special reflector on the rear of the car A



Practical Electronics December 1972

Features MOTORWAY SAFETY and WEIGHING HAZARDOUS MOVING LOADS

Automatic "Headway" Control

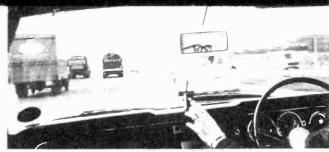
One example of automatic control in which brake and accelerator are operated as a result of obstacle detection, is being developed at the Lucas Group Research Centre near Birmingham.

Intended primarily for use on motorways where lane discipline is essential, this investigation has as its objective, the automatic maintenance of "headway" or the distance between moving vehicles at varying speeds.

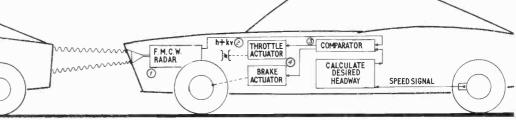
The equipment uses a 35GHz (8mm) continuous wave source, frequency modulated to give the required information on range and speed. The use of this high frequency enables both the transmitting and receiving "horns" to be compatible with automotive styling requirements while providing the narrow beam width required. An electronic computer carried on the vehicle makes calculations based on the reflected radar signals and relative velocity of the vehicle with respect to the leading vehicle. Brakes and throttle are then automatically adjusted to maintain a consistently "safe" distance.

The Government Department of the Environment are supporting the project with financial aid and facilities for testing at the Transport and Road Research

Laboratory.



- 1. FMCW is frequency modulated continuous wave radar which measures "headway" and relative vehicle velocity
- 2. The relative velocity kv caused by Doppler shift is such that it enhances the effect of headway h
- 3. Headway is compared with desired headway, calculated from time vehicle speed to produce an actuating signal
- 4. The actuating signal adjusts vehicle speed by means of brake and throttle actuators, so that headway spacing of one second is maintained

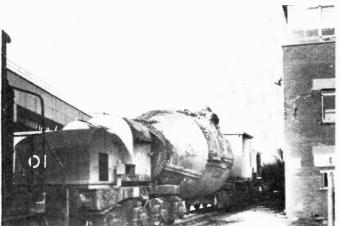


Weighing-in-Motion Scheme for Heavy Loads

NE of the problems encountered in heavy industry is the need to weigh large and sometimes hazardous loads on a continuously moving production line. Movement can influence erroneous measurements unless strict control of load vibrations is exercised. W. & T. Avery Ltd. the large weighing machine company have produced a "weighing-in-motion" system using a 27ft load-cell weighbridge linked to electronic sampling, recording, and data transmission instrumentation.

Four 500,000 pound capacity load cells are equipped with free-motion units to isolate them from shear forces and transmit analogue weight signals to a static digitiser in the weigh office. An analogue to digital converter interfaces these signals to the digital display and tele-

printer.

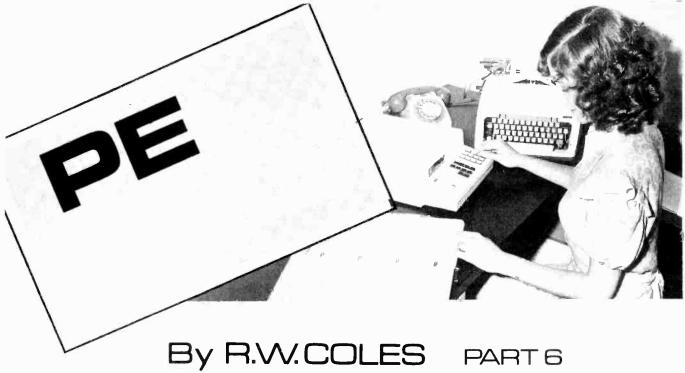




High frequency vibrations are attenuated by the rigid design of the weighing structure and a filter in the instrumentation. A digital filter eliminates the effects of low frequency vibrations. By sampling the resultant output signals at various time intervals, the readout displays the loading in increments of 0·1 ton. If the load is moving over the weighbridge too fast, an "excess-speed" signal inhibits the system until reset.

This system has been installed at the British Steel Corporation's Port Talbot Works, where up to 600 tons of molten iron is weighed *en route* to the steelmaking plant. The load is hauled in huge ladles on a railway

which passes over the weighbridge.



ANSWER (A) AND Z REGISTERS

AST month the construction of the ENTRY register was described together with the constant store and a fixed constant option. To follow this the logic and construction of the two registers which form the main part of the arithmetic section will be described, these being known as the ANSWER (A) register and the z register.

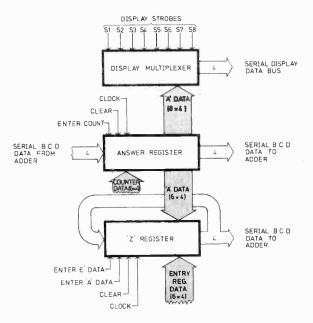


Fig. 6.1. Block diagram of the "A" and "Z" register sections of Digi-Cal

"A" AND "Z" REGISTERS

The A (ANSWER) and Z registers, together with the adder to be described next month, form the heart of the arithmetic unit of Digi-Cal. These registers are identical in capacity, being four (B.C.D.) digits "wide" and ten (decimal) digits "long". They differ in the type of input and output facilities which include both serial and parallel transfers.

Both are right-shift types, and are capable of shifting data at more than one million bits per second in the serial mode, when supplied with suitable

clocking signals.

The a register has an associated display multiplexer which is used to send the answer data down the display bus under the control of the display strobes provided by the display board previously described in Part 3.

The multiplexer is identical in principle to the ENTRY register version, but is two (decimal) digits longer to allow display of a full eight digit answer. The most significant two digits are not displayed and are used to allow error detection and decimal point manipulation.

A block diagram of the A and z register sections of Digi-Cal is given in Fig. 6.1 and this should be studied in conjunction with the overall system block diagram (Fig. 1.3) from the July edition, which did not include the display multiplexer.

REGISTER PARTITIONING

The division of the register circuitry to suit the constraints of a standard printed circuit system requires a good deal of thought to produce an arrangement which:

- (a) uses a minimum of "wasted" i.c. positions, and thus the minimum number of separate boards;
- (b) shares the number of input/output connections equally between boards so that one board does not demand more edge connector positions than are available on the standard board; and

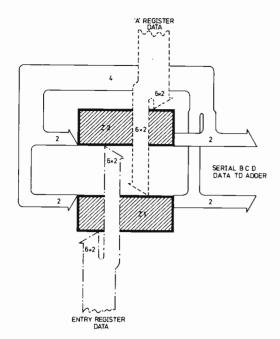


Fig. 6.2. The partitioning of the "Z" register is shown here, together with the inputs and outputs

(c) gives a layout arrangement which permits the interchange of identical halves of the circuit and thus cuts down the number of different types of board required.

With the ENTRY register last month, the circuit was divided vertically into three boards each carrying a two digit long register of B.C.D. width, plus a separate multiplexer board.

The A and Z registers on the other hand are divided horizontally into two ten-digit long registers, each two digits wide, giving four boards in all. The A register multiplexer is also split in this way, and in this case is incorporated on the same boards as the register proper.

All this sounds a little complicated but is easier to understand with reference to Fig. 6.2 and Fig. 6.3.

"A" REGISTER

The A register is built on two DL109/44 cards, each of which houses eight TTL i.c.s, two resistors, and two decoupling capacitors.

Making a register ten digits long and four wide would require twenty SN7474 dual p-type flip-flops as used in the ENTRY register, and this number would take up a lot of room, as well as presenting a mammoth wiring-up problem.

Fortunately the TTL series of complex functions known as medium scale integration (M.S.I.) contains a number of ready-made shift register circuits, and it is one of these, the SN7496, which is employed in the A register circuit.

A diagram of the SN7496 is shown in Fig. 6.4, and as can be seen this i.c. consists of a complete five-bit serial shift register in a 16 pin D.I.L. package.

The register comes complete with gating to allow a five-bit parallel input transfer when the PRESET input is activated, and has a separate output from each stage to allow parallel output transfers.

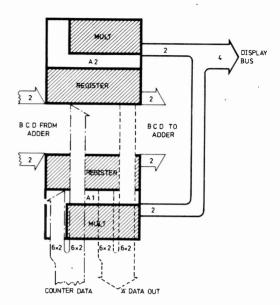


Fig. 6.3. The partitioning of the "A" register into the two halves known as the A1 and A2 registers is shown here

The CLEAR input will set all the flip-flops to the logic "0" output state, and is used to erase the stored contents of the register.

By connecting two of these i.c.s in series a tendigit register is formed, and by using four of these ten-digit sections, the required a register capacity is achieved, using eight SN7496 i.c.s (see Fig. 5.5).

OPERATION OF "A" REGISTER LOGIC

When an arithmetic programme is running, the data in the A register is shifted serially into the ADDER circuit, in synchronism with the data in the z register which is either added to or subtracted from the A data.

The output of the ADDER forms the serial input of the A register, so that after a group of ten clock pulses, the A register contains the sum (or difference) of the original A and Z register contents.

If the arithmetic operation required is MULTIPLICA-TION, then the contents of the A register have to be duplicated in the z register before the series of additions take place, and to facilitate this the parallel outputs of the A register are used to provide a single 24 bit transfer.

At the end of a DIVISION, the answer is represented by the state of the counter, and before this can be displayed it has to be transferred to the A register. This is also carried out in a single 24 bit transfer, this time using the parallel PRESET inputs of the SN7496s.

In each of these transfers the initiation is provided by a control pulse from the programme.

MULTIPLEXER

The multiplexer consists of a series of SN7401 open-collector gates, with their outputs "wired-or" to give the required four-bit data-bus. It is formed in the same way as the ENTRY register multiplexer.

The eight strobes or "character call-up" lines are produced in a sequence starting at the most significant end of the register, each one activating a group of four gates to send a single B.C.D. group to the display.

In the case of this multiplexer, the data-bus is produced in two, two-bit halves as a consequence of the partitioning arrangement mentioned earlier. This division of the multiplexer into two physically separate sections means that the display strobes have to be connected to both board Al and board A2.

"Z" REGISTER

Like the A register, the z register is housed on two DL109/44 plug-in cards. This register is identical in size to the A register, being ten by four in format, but because of its different role in the arithmetic operations of the calculator, different integrated circuits are employed.

A glance at Fig. 6.1 shows that the Z register is required to accept parallel transfers from two sources, the A register and the ENTRY register. It is not required to provide parallel outputs, only serial outputs being needed to feed the ADDER.

These different input/output requirements preclude the use of SN7496 shift register elements, since these devices can only accept a single parallel input transfer without extensive external gating. Luckily, it is still possible to enjoy the advantages of M.S.I. in this circuit because another device which suits our needs, the SN7494, is available.

The SN7494 is a four-stage serial shift register element with provision for parallel loading from two separate sources, under the control of internal gating.

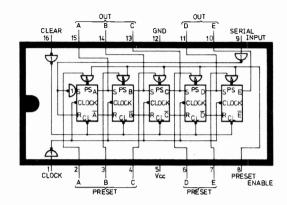


Fig. 6.4. The internal logic of the SN7496 integrated circuit

A logic diagram of this device is shown in Fig. 6.6 where is can be seen that the two sets of parallel inputs, IA to ID and 2A to 2D are presented to the PRESET inputs of the flip-flops via four AND-OR-INVERT gates, the appropriate set of input data being selected by the PRESET1 or PRESET2 control line.

Note that output connections are not provided from the A, B, and C flip-flops, which as previously stated, is quite satisfactory for this application.

REGISTER ASSEMBLY

Connecting two SN7494s in series gives a register eight digits long, which falls short of the requirement of ten digits. Therefore two more stages are added

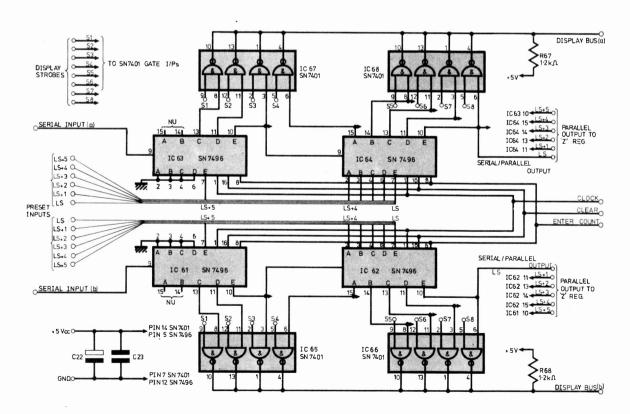


Fig. 6.5. The logic contained on the A1 register board. The A2 board is identical to this

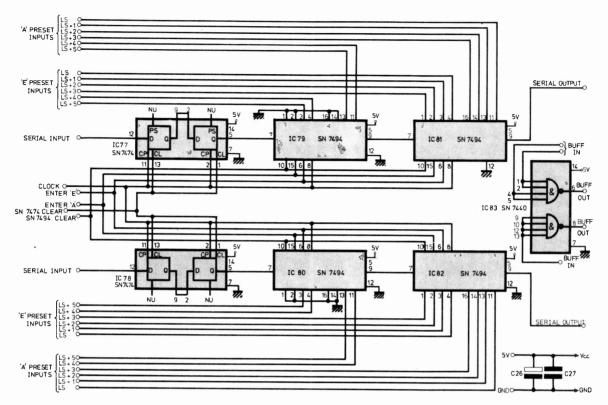


Fig. 6.7. The logic contained on the Z1 register board is shown here. The Z2 board is identical to this

in the form of an SN7474 dual D flip-flop. If these extra stages are placed at the "most-significant" end of the register, no extra input gating will be required since only the six "least-significant" stages are required to accept parallel input transfers. This is the approach adopted for the z register and the resulting circuit is assembled from eight SN7494s and four SN7474s, giving the required total number of 40 flip-flops.

The circuit of one of the two identical z register boards is shown in Fig. 6.7 where it can be seen that in addition to the shift register components, an SN7440 dual buffer gate is incorporated.

The connections to these gates are made external to the DL109 cards because these gates are used for different jobs on each of the two cards, and

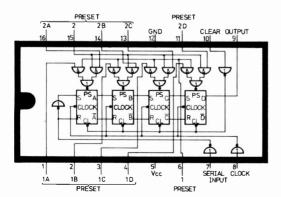


Fig. 6.6. The internal logic of the SN7494 integrated circuit

internal connection would prevent interchanging these when required.

One of the four buffer gates is used to invert the CLEAR z signal from the programme to make it compatible with the CLEAR inputs of the SN7474 devices, which operate on low inputs, as opposed to the SN7494 CLEAR lines which operate on high inputs.

The remaining gates are used to buffer the z register PRESET1 and PRESET2 lines, and in the OVER-FLOW logic.

"Z" REGISTER OPERATION

The most important operational aspect of the z register is that it operates in a recirculating mode, which means that not only is its output fed to the ADDER, but also back to its own input, to give an endless loop.

This feature is important because it means that the register contents are not altered no matter how many bursts of ten clock-pulses are applied in the course of an arithmetic operation.

This facility is required in the MULTIPLY and DIVIDE programmes, where the contents of the z register are continuously added to or subtracted from the contents of the A register until the result is produced.

In these programmes the contents of the register can be used up to one million times in a single computation. Of course, this is not to say that the register contents are completely invariant, for when a particular set of data is finished with the register will be cleared by a CLEAR pulse from the programme, ready for new data to be entered in parallel from the ENTRY or A registers.

A AND Z BOARDS

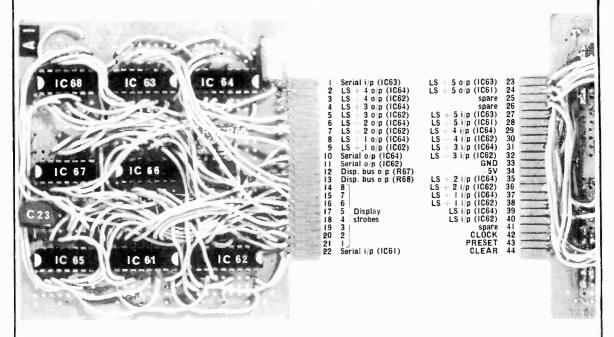


Fig. 6.8a. Layout of the i.c.s on the "A" register boards and function of the edge contacts, both boards being identical

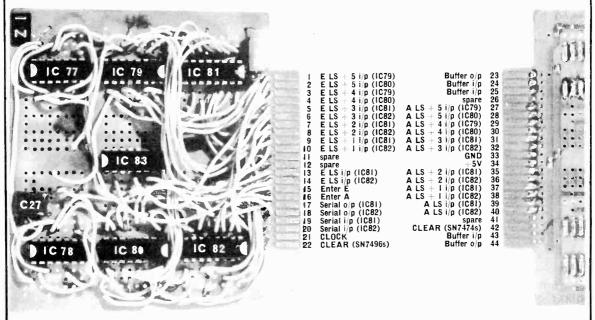


Fig. 6.8b. Layout of the i.c.s on the "Z" register boards and function of the edge contacts, both boards being identical

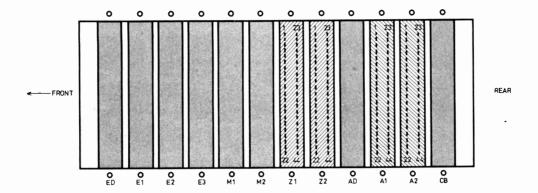


Fig. 6.9. Disposition of the edge connectors as seen from underneath the main chassis plate

CONSTRUCTION

The component layout arrangement for the A and z register boards is shown in Fig. 6.8.

These boards have a good deal of wiring to the edge contacts due to the large number of parallel input/output wires required, and some care is equired in laying this out so as not to produce very ong wiring runs or large wiring concentrations.

The registers are required to perform serial shifts at high speed which means that the interconnections associated with this aspect of the circuit, i.e. everything except the parallel input/output wiring, should be kept as short as possible to reduce stray capacitance effects. With this in mind it is advisable to wire up the serial interconnections and clock lines before the rest of the wiring (which is not critical) is added.

Wiring is normally carried out on the component side of the DL109/44 boards, but it was found with the prototype that wiring congestion can be alleviated on the Al and A2 boards by connecting the parallel output wiring to the edge contacts on the underside of the board.

EDGE CONNECTOR INTERCONNECTIONS

The edge connectors for these registers occupy the z1, z2, λ 1, and λ 2 positions on the chassis assembly (see Fig. 6.9), and are wired up in accordance with the wiring tables given. These tables (Fig. 6.10) are used by simply connecting the pin number required to the destination or destinations listed next to it in the table.

Each of these tables is complete, which means that a wire from the A register to the z register will be listed in both the A and the z register tables, so be sure to keep a record of wiring already carried out to prevent unnecessary duplication.

Again it is advisable to keep the wiring associated with serial transfers as direct as possible, and it is an idea to use a different coloured wire for these interconnections so that they may be easily identified later.

Where these serial data and clock lines exceed a few inches in length they should be routed as close to the chassis metal as possible to take advantage of its "ground-plane" properties. Interconnections to be treated with care are marked with an asterisk in Fig. 6.10.

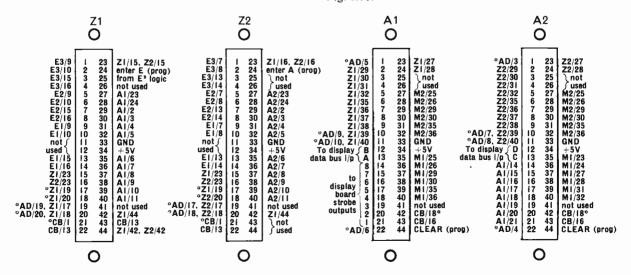
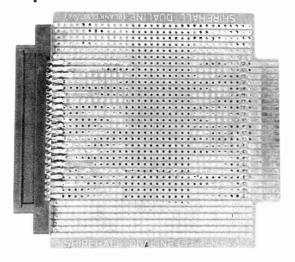


Fig. 6.10. Interwiring details of the four edge connectors holding the "A" and "Z" register boards. The asterisks show connections which need special care



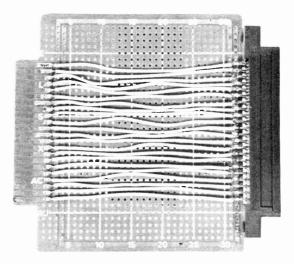


Fig. 6.11. Construction of a 44-way extension board which makes possible testing of boards in situ

TESTING

Testing these boards in an operational way is difficult at this stage and until the CLOCK board is constructed there is little that can be done except a check that the power supply lines are connected properly. For this reason it is essential that all wiring is double checked to remove wiring-up errors before proceeding.

EXTENSION BOARD

When the calculator nears completion and tests are possible in an operational situation, it will some times be required to measure a logic level, or inspect an interconnection while the logic boards are still connected in the circuit. As things stand this would prove difficult because of the close packing of the DL109 cards in their respective edge connectors.

To overcome this problem it is possible to construct an extension board which, when interposed between a particular board and its edge connector, has the effect of raising the board into a position where all its components and associated wiring are readily accessible, while still electrically connected to the rest of the circuit.

The layout for such an extension is shown in Fig. 6.11 where it can be seen that the component parts are simply an edge connector and a Shirehall DL107 board, together with some wiring.

The DL107 card is of the same physical size as a DL109, but instead of a printed wiring pattern to accept nine D.I.L. i.c.s, the DL107 has a Veroboard type of matrix, orginally intended for wiring up discrete components.

The construction of the extension consists of simply soldering the 22 ways of one half of the edge connector to the DL107 strips which terminate in gold plated edge contacts, then using single core wire to connect the other 22 edge connector tags to the corresponding DL107 edge contacts on the reverse side of the board.

COMPONENTS

A1, A2 BOARDS

Resistors

R67-R70 1.2k $\Omega \pm 10\%$ carbon

Capacitors

C22, C24 10µF 15V elect. (2 off) C23, C25 0.047µF (2 off)

Integrated Circuits

IC61-64, IC69-72 SN7496 (8 off) IC65-68, IC73-76 SN7401 (8 off)

Printed Circuit boards and sockets

Type DL109/44 boards (Shirehall) (2 off)
Type DPK165 edge connectors (Shirehall) (2 off)

Z1, Z2 BOARDS

Capacitors

C26, C28 10μF 15V elect. (2 off) C27, C29 0.047μF (2 off)

Integrated Circuits

IC77, 78, 84, 85 IC79–82, IC86–89 IC83, IC90 SN7494 (8 off) SN7440 (2 off)

Printed Circuit Boards and Sockets

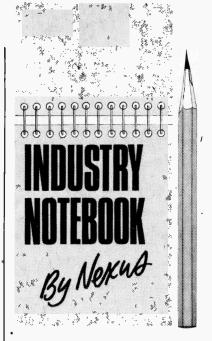
Type DL109/44 boards (Shirehall) (2 off)
Type DPK165 edge connectors (Shirehall) (2 off)

(In each case components are divided equally among the two boards which make up the A and Z registers)

The physical strength of the assembly can be improved by using a fillet of Araldite to join the edge connector and the DL107.

This simple servicing aid can come in very handy when testing any of the twelve Digi-Cal logic boards.

Next month: Clock Board.



COLD SHIVERS

Cold shivers ran up and down quite a lot of spines for a few brief moments when Dave Griffin, Motorola's director of marketing, Northern Europe, suggested there might be another slump in the semiconductor market in 1975. There was a sharp turndown in business in 1966/67 and the 1970/71 disaster is still painfully fresh in our memories. Is there a four-year cycle of slumps? Could be, says Griffin. Of course nobody really knows but Griffin's remarks got everybody, crossing their tingers.

Griffin was speaking at a one-day seminar organised by component distributor Celdis Ltd. A hundred delegates turned up to hear the speakers in the Sculpture Gallery at Woburn Abbey. Their wives and girl friends were invited too, but they were hived off during the business sessions and enjoyed themselves watching wildlife in the Game Park and admiring the treasures in the Abbey itself.

But the sessions were by no means all gloom. Griffin came clean on Motorola forecasts which, among a great pile of statistics gave a U.K. semiconductor market worth £80 million by 1974. Big growth area was confirmed to be MOS devices which should reach £10 million worth of business in the same year. Big surprise is the market for germanium power devices which was expected to drop off very severely but which still has £4 million worth of business a year, even today.

This year, said Griffin, the U.K. market will have bought 40 million integrated circuits and 600 million discrete devices. Average selling prices have dropped since 1968. Then, the average price for a discrete device was 25 cents and for

an integrated circuit 1.8 dollars. Today the averages are 20 cents and 1.2 dollars, respectively (dollar values are used universally in this type of comparison in the semi-conductor industry).

TIME AND MOTION

The automotive industry as a major consumer of semiconductors will not really take off until 1975. But electronic watches are already starting to be a good growth area. Motorola has an electronic kit which is sold to watch manufacturers. It consists of a quartz crystal, a CMOS oscillator, divider and buffer circuit equivalent to 312 transistors in a 6-lead ceramic package, and a microminiature stepping motor which drives the hands. Total power consumption is a mere 5 microamps from a 1-5V silver oxide battery which lasts for over a year.

Motorola has greatly improved the yield of the CMOS package for watches by the use of ion implantation in which dopant material is "fired" at the target at enormous velocities but in a manner which can be deliberately controlled.

Another of the speakers, Kim Morrell of Mullard, forecast expansion of the U.K. electronics industry to £1,800 million by 1980 of which some £260 million would be in components of all types. My own belief is that his figure is on the low side and we should do much better than that.

The Vice President of RCA Solid State Europe, Dr Joe Donahue, spoke on his company's solid commitment to European operations and to broadening the market base. The decision to set up in Europe was taken only three vears ago. Now, says Donahue, RCA Solid State has almost 1,000 emplovees in Europe, well over 500 of them at the new semiconductor plant at Liege.

TOGETHERNESS

On the theme of togetherness, Donahue reminded his audience that RCA grew out of the old British-owned American Marconi Company. That was way back in 1919 when RCA was formed at the request of the American government to acquire the Marconi interests. It was the first time I ever heard RCA even admitting British ancestry publicly, let alone boasting about it!

To round up an interesting day. Peter Turner of Hewlett-Packard spoke of the dramatic growth of the optoelectronics market. Apart from obvious uses such as displays. Turner stressed that a huge growth area lay in electrically isolated couplers. H-P has a new fast one

on the stocks promising a 20MHz bit rate with 2-5kV isolation, all in a small i.c. package. Overall optoelectronics sales in the U.K. could soar to £150 million per year by 1976 stated Turner.

So, on the whole, the news was good, especially for distributors who are currently handling some 20 per cent of all professional component supplies and are working hard to handle more.

CHATAWAY AT H-P

It was a great day for Dennis Taylor, managing director of Hewlett-Packard Ltd., when the Minister for Industrial Development, Mr Christopher Chataway, officially opened the 100,000sq ft extension to their South Queensferry plant. It more than doubles the area of the original unit built in 1966 and total employment at the plant has now risen to over 600.

Their total business in the U.K. is some £9 million and of total U.K. production 66 per cent is exported. Most famous of their instruments designed and built in the U.K. is the Microwave Link Analyser. To date over £4½ million worth have left the factory and 85 per cent went for export.

On the future, Taylor announced that they have just bought 33 acres of ground so we can expect further expansion although, chuckled Taylor, it will take a little time to expand into it. Hewlett-Packard has an R and D group of 50 people at South Queensferry and at least two completely new UK-designed instruments will be released by the end of the year.

RESETTLEMENT

An ex-editor in electronic publishing, T. Jeffrey Burton, and now a press relations consultant, has recently run a one-day seminar for RAF electronic technicians nearing the end of their service.

The idea was to give them a teach-in on the structure of the electronics industry and the job opportunities within it. Speakers include representatives of the electronics press, of the Society of Radio and Electronics Technicians (SERT), the Post Office and companies of the status of IBM and Exchange Telegraph.

Although the scientific and R and D ends of the business are not recruiting heavily at the moment, it seems that good technicians are hard to come by in the industry and are eagerly sought. The resettlement briefing, held at RAF Newton, near Nottingham, should help the boys in blue to ease themselve's back into civvy street and do a good turn to the electronics industry as well.



A selection of readers' suggested circuits. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought. This is YOUR page and any idea published will be awarded payment according to its merits.

VISIBLE SPEED READOUT FOR A PROJECTOR

Many home movie projectors rely for speed control on a rheostat which gives a film transport speed continuously variable from around 12 f.p.s. to around 25 f.p.s. This kind of control can have advantages over fixed (i.e. switched) controls, because many of the old silent films were shot at film speeds somewhere between 16 and 24 frames per second. Moreover, not all home movie cameras run at the same speed.

But anyone projecting films with a rheostat control will know that the snag with these controls is their unreliability as a positive guide to actual film speed. The same rheostat setting cannot be relied on to produce exactly the same speed on two occasions.

A few years ago I used a car tachometer or rev. counter to provide a direct visible readout of film speed.

Tachometers function by sensing the voltage pulses proportional to projector shaft speed; it is only necessary to produce low voltage pulses from the projector itself and feed them to an inductive load across which the tachometer is connected.

Experience shows that the most reliable source of pulses is from a make-and-break contact associated with the projector main drive shaft, but of course any positively driven shaft will do. All that is necessary is to attach a small spring metal strip (such as an old relay contact strip) to an insulating block which is secured (e.g. glued) to the projector chassis so that the spring strip presses against the shaft (Fig. 1).

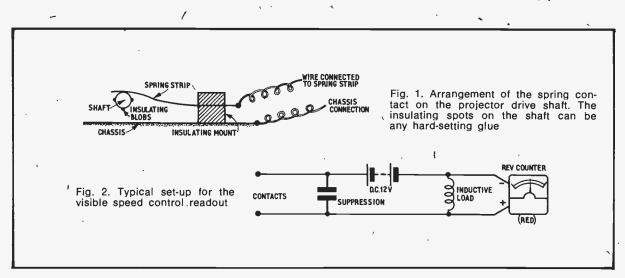
A blob (or blobs—see later) of Araldite or other hard insulating material is painted on the shaft so that, as it revolves, the spring strip will alternately make with the metal shaft and break by contacting an insulating blob. By connecting leads between the spring strip and projector chassis (which will of course be electrically connected to the shaft) a make-and-break connection is easily achieved which can be used to produce low voltage pulses when in circuit with a low voltage source.

Tachometers or rev. counters come with two leads, one of which is red or marked "positive" for connection to the positive side of the supply.

The tachometer dial reading will not of course necessarily give a true r.p.m. reading for the projector shaft, but this is not important. By timing a film loop through the projector and marking the dial accordingly, points of reference for actual speeds of 16, 18 and 24 frames per second can be marked on the dial and the projector brought reliably to these speeds at any time in the future by operation of the rheostat.

By virtue of this arbitrary scaling, there is wide latitude of components, virtually any inductance or low voltage d.c. source that produces a healthy dial reading being acceptable. For guidance, 9 or 12 volts smoothed d.c. from a battery eliminator should be fed through the make-and-break contacts to the inductive load, for which the primary of a 5:1 transformer has proved ideal. To avoid radio or television interference, a 0·1 or 0·01µF capacitor should be connected across the contacts.

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	1N253	0.88 0.50	ASY28	0·32 0·25	10 1 2/12	0.80	OAZ223 OAZ224	0.45	ZT21	0.25
	1N256 1N645	0.50	ASY29	0.80	BYZ13 BYZ15	0.25	OAZ241	0.22	ZT43	0.25
	1N725A	0.25 0.20	ASY36 ASY50	0·25 0·17	BYZ16	1.00 0.82	OAZ242 OAZ244	0.28 0.22	ZTX107 ZTX108	0·15 0·12
	1N914 1N4007	0.07	ASY51	0.40	BYZ88C	3 V 3	OAZ246	0-23	ZTX300	0.12
	16113	0.20 0.15	A8Y53 A8Y55	0·20 0·20	CIII	0·15 0·65	OAZ290	0·38 0·50	ZTX304	0.25
	16130 16131	0·18 0·18	A8Y62	0.25	CR81/05	0.25	OC16 OC16T	0.88	ZTX500	0.16
	18202	0.23	A8Y86 A8Z21	0.38 0.42	CRS1/40 CS4B	0.45 2.50	OC19 OC20	0-37 0-85	ZT X 503 ZT X 531	0·17 0·25
	2G371 2G381	0·22 0·25	A8Z23 AUY10	0.75	CS10B	3.18	OC22	0.50		
	2G414	0.30	A U 101	0.98 1.50	DD000 DD003	0-15 0-15	OC23 OC24	0.60 0.60	CIRCUIT	ATED S
	2G417 2N404	0.22	BC107 BC108	0·10 0·10	DD006 DD007	0.18	OC25	0.37	7400	0.20
	2N697	0.15	BC109 BC113	0.10	DD007	0.38	OC26	0.25	7401 7402	0.20
	2N698 2N706	0-40 0-10	BC113 BC115	0·15 0·20	GD3 GD4	0-33 0-05	OC28	0.60	7402	0.20 0.20
	2N706A	0.12	BC116	0.25	GD5	0.88	OC29 OC30	0.60 0.40	7404	0.20
	2N708 2N709	0-15 0-63	BC116A BC118	0.30 0.25	GD8 GD12	0.25 0.05	OC35	0.50	7405 7406	0.20
	2N1091	0.83	BC121	0.20	GET102	0.80	O'C36	0.60	7407	0.30
	2N1131 2N1132	0.25 0.25	BC122 BC125	0-20 0-68	GET103 GET113	0.22 0.20	OC41	0.25	7408 7409	0.20
	2N1302	0.18	BC126	0.65	GET114	0.15	OC42 OC43 OC44	0-30 0-40	7410	0·20 0·23
	2N1303 2N1304	0·18 0·22	BC140 BC147	0.55 0.15	GET115	0.45 0.50	OC44	0.17	7412	0.42
	2N1305	0.22	BC148	0.13	GET116 GET120	0.25	OC44M OC45	0.12	7413	0.30
	2N1306 2N1307	0.25	BC149 BC157	0·15 0·15	GET872	0-30 0-25	OC45M OC46	0.18	7416	0.30 0.30
	2N1308	0.25	BC158	0.12	GET875 GET880	0.37	OC57	0.80	7420	0.20
	2N2147 2N2148	0.75	BC160 BC169	0.63 0.13	GET881	0.25	OC58 OC59	0.60 0.65	7422 7423	0-48 0-48
	2N2160 2N2218	0.60	BCY31	0.35	GET882 GET885	0.25	OC66 OC70	0.50	7425 7427	0-48 0-42
	2N2219	0.20 0.20	BCY32	0.55	GEX 44 GEX 45/1	0.08 0.10	OC70 OC71	0·12 0·12	7428	0.50
	2N2369 A 2N2444		BCY33 BCY34	0.25 0.30	GEX 45/1 GEX 941	0.15	OC72	0.20	7430 7432	0.20 0.42
	2N2613	1.99 0.28	BCY38 BCY39	0.40	GJ3M GJ4M	0.25 0.38	OC72 OC73 OC74	0.30	7433	0.70
	2N2646 2N2904	0.45 0.20	BCY39 BCY40	1.00 0.50	GJ5M GJ7M	0.25	OC75	0.25	7437 7438	0-65
	2N2904A	0.25	BCY42	0.25	HG1005	0.87 0.50	0C76 0C77	0.25 0.40	7440	0.20
	2N2906 2N2907	0.20	BCY70 BCY71	0·15 0·20	H8100A MAT100	0.20 0.25	OC78 OC79 OC81	0.20	7441AN 7442	0-75 0-75
	2N2924	0.23	BCZ10	0.35	MAT101	0.30	OC81	0-22 0-20	7450	0.20
	2N2925 2N2926	0·15 0·10	BCZ11 BD121	0.50 0.65	MAT120 MAT121	0.25	OC81D OC81M	0.20	7451 7453	0·20 0·20
	2N3054	0.50	BD123	0.80	MJE520	0.87	OC81DM	0.18	7454	0.20
	2N3055 2N3702	0.75 0.10	BD124 BDY11	0·75 1·62	MJE2955 MJE3055	1.37 0.87	OC81Z	0-40 0-25	7460 7470	0·20 0·30
	2N3705	0·10 0·28	BF115	0.25	NKT128	0.85	OC82 OC821)	0.20	7472	0.30 0.40
	2N3706 2N3707	0.12	BF117 BF167	0.50 0.25	NKT129 NKT211	0.30	OC83 OC84	0-25 0-25	7473 7474	0.40
	2N3709 2N3710	0·10 0·10	BF173	0.25 0.85	NKT211 NKT213 NKT214	0.25	OC114 OC122	0.38	7475 7476	0.55 0.45
	2N3711	0.10	BF181 BF184	0.20	NKT216 NKT217	0·15 0·37	OC122	0.60	7480	0-80
	2N3819 2N5027	0.85	BF185 BF194	0.20 0.17	NKT217 NKT218	0·35 1·13	OC123 OC139 OC140	0.25	7482 7483	0.87 1.00
	2N5088 28301	0.83 0.50	BF194 BF195 BF196	0·15 0·15	NKT219 NKT222	0.33	OC141 OC169	0.60	7484 7486	0.90 0.45
	28304	0.75 0.37	BF197 BF861	0.15	NKT224 NKT251	0.22	1 00170	0·20 0·25	7490	0.75
	28501 28702	0.87	BERGA	0.28	NKT251 NKT271	0.24 0.25	OC171 OC200 OC201	0.30 0.40	7491AN 7492	I-00 0-75
	AA129 AAZ12	0.20	BFX12 BFX13 BFX29	0.20	NKT272 NKT273	0.25	OC201	0.70	7493	0.75
	AAZ13	0.80 0.12	BFX29	0·25 0·25	N K T 974	0·15 0·20	OC202 OC203	0.80 0.40	7494 7495	0-80 0-80
	AC107 AC126	0.37 0.20	BEX30	0.25	NKT275 NKT277 NKT278	0.25 0.20		0.40	7496 7497	1.00 6.25
	AC127	0.25	BFX35 BFX63	0.50	NKT278	0.25	OC205 OC206 OC207	0.75	74100	2.50
	AC128 AC187	0.20 0.25	BFX84 BFX85	0.25 0.30	NKT301 NKT304	0.40 0.75	OC207	0-90 0-20	74107 74110	0-50 0-80
	AC188	0.25	BFX86	0.25	NKT403	0.75	OC460 OC470 OCP71	0.80	74111	1.45
	ACY17 ACY18	0.25	BFX87 BFX88	0.25 0.20	NKT404 NKT678	0.55 0.30	OCP71 ORP12	0-97 0-50	74118 74119	1.00 1.90
	ACV19	0.25 0.20	BFY10	1.00 1.25	NKT713 NKT773	0.25 0.25	ORP60	0.40	74121	0.60
	ACY20 ACY21	0.20	BFY11 BFY17	0.25	NKT777	0.38	ORP61 819T	0·42 0·80	74122 74123	1.35 2.70
	ACY22 ACY27	0.10	BYF18 BFY19	0.25	078B 0A5	0-38 0-20	SAC40 SFT308	0.25	74141 74145	1.00 1.50
	ACY27 ACY28	0.17	BFY19 BFY24	0.45	OA6	0.12	ST722 ST7231	0.38	74150	3.35
	ACY39 ACY40	0.50 0.15	BFY44 BFY50	1.00 0.22	OA47 OA70	0·10 0·10	ST7231 SX68	0.63	74151 74154	1·10 2·00
	ACY41 ACY44	0.15	BFY51 BFY52	0.20	OA71	0·10 0·10	8X631 8X635	0.30	74155	1.55
	AD140	0.50	BFY53	0.22 0.17	OA73 OA74	0.10	8X 635 8X 640	0.40	74156 74157	1.55 1.80
	AD149 AD161	0-50 0-87	BFY64 BFY90	0.42	OA79 OA81	0·10 0·08	8X641	0.55	74170	4.10
	AD162	0.87	BSX27	0.50	OA85	0.12	8X642 8X644	0.60 0.75	74174 74175	2.00 1.35
	AF114	0-30 0-25	BSX 60 BSX 76	0.98 0.15	OA86 OA90	0.15	SX 645 V15/30P	0.75	74176	1.60
	AF115	0.25	BS Y26	0.18	OA91	0.07	V30/201P	0.75	74190 74191	1.95 1.95
	AF116 AF117	0.25	BSY27 BSY51	0-17 0-50	OA95 OA200	0·07 0·07	V60/201 V60/201P	0.50	74192 74193	2·00 2·00
	AF118 AF119	0.62 0.20	B8Y95A B8Y95	0·12 0·12	OA202 OA210	0·10 0·25	X A 101	0.10	74194	2-50
	AF124	0.25	BT102/50	00 R	OA211	0.30	X A102 X A151	0.18	74195 74196	1.85 1.50
	AF125 AF126	0.20 0.17	BTY42	0.75 0.92	OAZ200 OAZ201	0.55 0.50	X A 152	0.15	74197	1.50
	AF127	0.17	BT Y 79/1	00R	OAZ202	0.42	X A 161	0.25	74198 74199	4.60 4.60
	AF139 AF178	0-80 0-55	BTY79/4	0.75 00 R	OAZ203 OAZ204	0.42	XA162 XB101	0.25		
	AF179 AF180	0.65 0.52	BY100	1.25 0.15	OAZ205 OAZ206	0.42	X B102	0.10	Plug in so- low prof	ile
	AF181	0-42	RV196	0.16	OAZ207	0.47	X B103 X B113	0.25 0.12	14 pin DI	L
	AF186 AFY19	0·40 1·18	BY127 BY182	0-17 0-85	OAZ208 OAZ209	0.32	X B121	0.48	16 pin D1	0-15
	AFZ11	0.60	BY213	0.25	OAZ210	0-32	ZR24	0.68		0.17

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No. 16 oz 112 0.5 1 4 8.3 × 79 1 0.2 2 0 7.0 × 3 2.0 3 2 8 9 × 20 3.0 4 6 10.2 × 21 4.0 6 8 12.1 × 117 6.0 7 8 12.1 × 117 6.0 7 8 12.1 × 88 8.0 10 0 14.0 × 89 10.0 12 2 14.0 ×	20						
No.	re cm. Secondary Taps						
No.	re cm. Secondary Tops P & P & P 9.5 × 6-7 0-24-30-40-48-60V 1-38 36 8-9 × 8-6 2-94 42 9-5 × 11-48 36 9-5 × 8-6 4-48 52 9-5 × 11-4 5-78 67 8-7 22-1 × 12-1 × 12-1 8-37 82 12-7 × 16-5 13-85						
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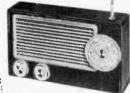
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RECENTLY I set about designing a system to enable me to remotely switch on and off two or more table lamps. I wished to be able to switch the lights on and off at any of three points regardless of the state of the switches at the other two.

This I decided could best be achieved by placing an electrically alterable bistable switch near the power point that fed the two lamps and running a twin flex lead from the bistable, connecting the three switches in parallel. Pushing on and releasing any switch would then change the bistable from on to off,

or off to on depending on its history.

Since I had several suitable relays, and triacs are a little costly, I decided to use a relay to do the actual work of switching the lamps. The circuit I originally tried was the conventional type of bistable.

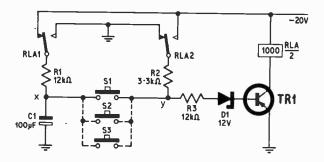


Fig. 1. Circuit diagram of the light control

Unfortunately, it had the disadvantage of requiring a fast edge to switch reliably, a faster edge than one could hope to regularly achieve with a mechanical switch. This meant, therefore, placing a monostable between the mechanical switch and the bistable. A rethink at this point produced the circuit shown in Fig. 1.

If TR1 is off and S1 is open, contacts RLA1 and RLA2 will be closed, point y will be at zero potential and capacitor C1 will charge to -20V through R1. If S1 is then closed, point y is reduced to the potential of point x, i.e. -20V. The Zener diode D1 then conducts, resistor R3 limiting the current, and TR1 switches on. The relay is energised and the relay switches over.

The circuit will now take the form shown in Fig. 2, points x and y at $\frac{12 \times 20}{(3 \cdot 3 + 12)}$ negative volts (approximately -16V), which is just sufficient to maintain TR1 conducting. When S1 is opened again, point y goes to -20V potential maintaining TR1 in con-

duction; capacitor C1 discharges through R1 to zero. When S1 is pressed close, point y is reduced instantaneously to zero, TR1 switches off and the relay contacts revert back to their original state.

Points x and y should now be at $\frac{3.3 \times 20}{3.3 + 12}$ negative

volts (roughly -4V), insufficient to cause the Zener diode to conduct and TR1 remains off. When S1 is released (open) y goes to zero and x charges to -20V through resistor R1. The cycle may now be repeated.

Because of the delay in charging capacitor C1 the circuit will only change state when there is a minimum of two seconds delay between switching pulses, i.e. between S1 going off and coming on again. In certain circumstances this could be useful.

The delay could be reduced by reducing the values of R1 and R2 or C1. This is limited of course since C1 must not be allowed to charge or discharge through R2 in that instant when S1 is closed and the relay has not switched; in other words the minimum vales of C1, R1 and R2 are primarily limited

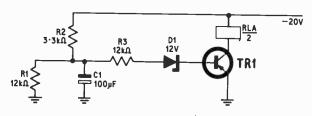


Fig. 2. Effective circuit when S1 is closed

by the inertia of the relay. It should also be remembered that lower values of R1 and R2 will require greater transient power pulses from the supply.

It was found that the bistable operated satisfactorily with up to about 50 ohms between SI and point x. Line resistance to SI is therefore not important.

The switch pulse duration may be any length from a few hundred milliseconds (sufficient to switch the relay) to infinity.

The power supply is not critical and a bell transformer driving an unregulated voltage doubler was found satisfactory. Using a G.P.O. 1,000 ohm relay the circuit uses approximately 20mA when switched on, and negligible current in the off state.

Any relay with double changeover contacts, other than very low coil resistance types, should work. The line voltage should be approximately the relay working voltage. The Zener diode should be 0.6×10^{-6} line voltage. Additional heavy duty contacts would be required for switching the lamps.

An *npn* transistor may be used in the circuit if preferred. In this case the Zener must be reversed, and the supply and electrolytic polarities changed.

P. King, Withington, Manchester.

MODEL TRAIN CONTROL



THE circuit depicted in Fig. 1, was designed to automatically control the running of two trains through a single-line section, both trains always travelling in the same direction as each other.

Referring to Fig. 2, points A and B are set for the inner loop. Whilst train 2 is travelling round the single-line loop train 1 is held in isolating section X. Isolation of sections X and Y is controlled by the points blades at B. Track current is fed to either X or Y not both.

As train 2 passes position L, it interrupts a light beam focused on a light dependent resistor PCC1 (Fig. 1.) thereby triggering the desired sequence of switching operations. First point A changes to outer and then point B also changes to the outer track.

When point B is set for the outer section, current is fed to section X, train 1 starts up and proceeds around the single line section; the sense of points B will cause train 2 to halt in section Y.

from the collector of TR1 switches on TR2 and TR3, which in turn energises RLA.

Relay RLA, however, remains closed for a very short time until capacitor C1 has charged up and consequently switched off TR2 and TR3. Relays RLA and RLB are wired in a master-slave relationship, for while RLA is closed a secondary set of its contacts is being used to charge up capacitor C2, via R6 and the RLA1 contacts P and R. When RLA drops out contact P makes contact with contact Q (its normal state) and capacitor C2 discharges via R7 and TR4 base. This then switches on TR4 and TR5, but as before the pulse is momentary, until C2 has discharged sufficiently to reverse bias TR4.

After one cycle of operations has been completed, further triggering is not possible until after a delay (approximately 10sec) during which C1 discharges.

If desired, a variable resistor may be substituted for R2 to provide sensitivity control of the PCC1. The relays used were 12V types. The contacts on RLA2 need to be of the break-before-make type, but the contacts RLA2 and RLB1 need only be simple on-off types; normally off.

The light source used was an ordinary flashlight bulb masked to shine through a 4in aperture into a 3in long cardboard tube housing PCCI at the far end

J. Duffill, Southam.

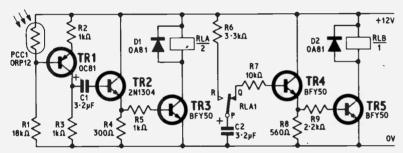


Fig. 1. Circuit diagram for the light operated model train controller. Note that C1 and C2 are electrolytics

As train I now passes position L it triggers off the same switching sequence as before, except this time the moving train is now on the outer loop and the points are therefore changed from outer to inner. By the time train I is halted in section X train 2 is on the move again, we are back at the beginning of the sequence of operations and the whole cycle repeats.

The points are actuated by point motors which consist of a 2-coil solenoid and an independently wired 2-way switch that changes synchronously with the points motor, see Fig. 3. Since for reliable operation these motors need a relatively high current, it was arranged to operate them in sequence. They also require a one-shot pulse to avoid overheating the coils.

The pulses are supplied by sets of contacts on the relays RLA2 and RLB1, which close in sequence. The cross-wiring of the 2-way switches on the points motors (Fig. 3) provides a flip-flop arrangement by which the closing of RLA2 causes point A to change to the sense determined by the setting of the switch S2 on the points motor M2. Similarly, when RLB1 closes, immediately on RLA2 dropping out, point B changes under control of the switch S1 on motor M1.

The circuit Fig. 1 comprises two relay buffer stages and a light-operated circuit for triggering. Interruption of the light beam at L causes TR1 to switch on because of the increased resistance of PCC1. Current

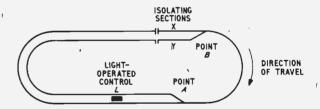


Fig. 2. Typical track layout

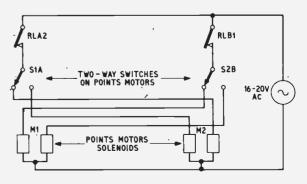


Fig. 3. Switch wiring arrangement

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8µF	450V	17p	2,000µF	50V	53p	
16µF	450V	18p	2,500µF	25V	45p	
25µF	25∨	7p	2,500µF	50V	60p	
25µF	50 V	10p	3,000µF	25V	48p	
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100µF	50V	Hp	8-16µF	450V	20p	
250µF	25V	I4p	16-16µF	450V	27 p	
250µF	50V	17p	16-32μF	450V	63p	
500µF	25∨	18p	32-32µF	450V	49p	
500µF	50 V	25p	50-50µF	350V	38p	

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1441144	~				
IμF	63V	6р	47μF	16V	7 _P
2.2µF	63V	6р	47µF	25V	6p
3-3µF	63 V	6p	68µF	16V	6р
4-7µF	63 V	6p	100µF	107	6р
8µF	40V	7p	220µF	16V	7p
10µF	25V	. 6p	330µF	16V	Hp
10µF	64V	7p	470µF	107	Hp
16µF	40V	7p	1,000µF	16V	19p
33µF	16V	6p	1,500µF	16V	23p

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2∯in × 5in	24p	25p					
3žin × 3žin	24p	25p					
3≩in × 5in	27 p	29p					
l7in × 2∔in	75p	57p					
l7in × 3∄in	61	75p					
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Jack, 34mm screened
Jack, ‡in unscreened
Jack, ‡in screened
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3p	D.I.N. 5 pin, 180°	9p
6p	D.I.N. 5 pin, 240°	9p
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4p	Jack, in unswitched	15p
7 _D	Jack, Jin switched	17p
5p		
	Jack, stereo, switched	24p
6p	Phono, single	5p
6p	Phono, 2 on a strip	7p
6р	Phono, 3 on a strip	9p
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3-3pF	500V	S/M	71p	0.0033µF	500V	Poly.	6р
5pF	500V	S/M P.S.	7 1 p	0.0033µF	1,000V	MDC	6р
10pF	125V	P.S.	5p	0.0036µF	500V	S/M	15p
10pF	500V	S/M	71p	0.0047µF	125∨	P.S.	9p
15pF	1'25V	P.S.	5p	0.0047µF	500 V	Poly.	6p
15pF	500V	Cer.	4p	0.0047µF	500V	S/M	20p
18pF	500V	S/M	71p	0 0047µF	1,000V	MDC	6р
22pF	125V	P.S.	5p	0.005µF	100V	Mylar	3p
22pF	500V	5/M	71p	0.005µF	500V	Cer.	5p
25pF	500V	S/M	7 i p	0.0068µF	125V	P.S.	101p
27pF	500 V	Cer.	4р	0.0068µF	500 V	P.S. 5/M	30p
33pF	125V	P.5.	5p	0.0068µF	500V	Polv	60
33pF	500∨	S/M S/M	71P 71P	0.0082µF	125V	P.S. S/M	101p 30p
39pF	500V	S/M	7 ½ p	0.0082µF	500V	S/M	30p
47pF	125V	P.S.	5p	0.01 µF	187	Disc	4p
47pF	500V	Cer.	4p	0.01µF	125V	P.S.	10 p
SOPE	500V	5/M	71p	0.01µF	160V	Poly.	4p
56pF	500V	S/M	7 1 P	0.01µF	250V	M.F.	3p
68pF 68pF	125V 500V	P.S.	5p	0.01µF	400V	Poly.	3 p
	500 V	S/M	7 P	0.01µF	500V	Cer.	. 5p
75pF		S/M S/M	71P	0.01µF	500V	S/M	30p
82pF 100pF	500V	3/1-1	7 } P	0.01µF	600V	MDC	7p
I OOpF	500V	P.S. S/M	5р 7 1 р	0 01μF	1,000V 160V	MDC Poly.	9p
I00pF	500 V	Cer.	5p	0.015µF	400V	Poly.	3p
120pF	500 V	5/M	7 i P	0·015μF 0·02μF	100V	Mula-	3p
150pF	125	P.S.	′3p	0· 0 22μF	187	Mylar Disc	
150pF	500V	S/M	71P	0.022µF	250V	M.F.	5p 3p
150pF	500 V	Cer.	5p	0 022µF	400V	Poly.	3p
180pF	500 V	S/M	710	0.022µF	600V	MDC	7 iP
200pF	500V	S/M	71p 71p	0.022µF	1,000V	MDC	10p
220pF	125V	P.S.	5p	0.033µF	250V	M.F.	4p
220pF	500V	Cer.	5p	0.033µF	400 V	Poly.	4p
250pF	500V	S/M	8p	0.047µF	- 12V	Disc	6p
270pF	500V	Cer.	5p	0.047µF	160V	Poly.	3p
300pF	500V	S/M	8p	0-047µF	250V	M.F.	3p
330pF	125V	P.S.	5p	0.047µF	400V	Poly.	4p
330pF	500V	S/M	8p	0.047µF	600V	MDC	8p
390pF	500V	5/M	8p	0.047µF	1,000V	MDC	10p
470pF	125V	P.S.	5p	0·1µF	30V	Disc	6р
470pF	750V	Disc	5p	0·1µF	250V	M.F.	4р
500pF	500 V	S/M	8р	0 IμF	400V	Poly.	5p
560 pF	500V	5/M	8p	0·1μF	600V	MDC	10p
680pF	125V	P.S.	6р	0·1μF_	1,000∨	MDC	14p
680pF	500V	S/M	8р	0·15µF	250V	M,F.	5p
820pF	500V	S/M	8р	0.22µF	160V	Poly.	6p
0.001µF	100V	Mylar	3p	0-22µF	250V	M.F.	5p
0.001µF	125V	P.S.	6р	0.22µF	400V	Foil	10p
0.001µF	400 V	Poly. S/M	3p	0-22μF	1,000V	MDC	15p
0.001µF	500 V		100	0·33µF	250V	M.F.	8p
0.001µF 0.001µF	500V 1,000V	Cer. MDC	5p	0·47μF	250V 400V	M.F.	8p
0.0015µF	400V	Poly .	6p	0·47μF 0·47μF	1,000V	Foil MDC	15p
0.0015µF	500V	S/M	3p 10p	1-0µF	250V	M.F.	25p
0.0015µF	500V	Cer.	5p	ι υμι	230 V	rt.r.	130
0.0018µF	500 V	S/M	100	Note:			
0.002µF	100V	Mylan	3p		lver mica	1% 10	I.
0.002#E	500 V	Cer.	5p	P.S. = n	olystyren	e 21%	tol.
0.0022µF	125V	P.S.	6р	MDC-	a.c. ratin	g = 300	V.
0·0022μF 0·0022μF	500V	P.S. 5/M	10p		fullard m		
0.0022µF	1,000V	MDC	6р	Cer. = c			

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	An aerosol spray of a printed circuit	providing a con	and auickly	ans of pr	oducing			
	Method: Spray c transparent film u	pon which cire	uit has bee	n drawn.	Expose	to light	t. (No r	r with
	use ultra-violet.) S Light sensitive ae Developer and Et	rosol spray		e and etc	• •	41	00 pl	
	TRA	NSISTORS	AND IN	EGRAT	ED CII	RCUIT	s	
	FJH231/7401N		le 2-input p					12p
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	FJH141/7440N	Dual 4-in	PUL NAND	buffer g	ate			12p
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	FJJ131/7474N	Edge-trig	gered dual	D-type fi	ip-flop			32p
	FJH201/7482N	2-bit bina	ry full add	er				88p
Į	F11151/7491AN	, =						

50p.	"ODDS	: & E	NDS''	Ips	q.
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125µf 4 volt		/		

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602 Amplifier as above but with single tone control (8½inW × 2½inD) £5-95 Mains Transformer (14V) for 600 series amps 98p Lead, plug and socket set 38p Cheques, P.O's, plus 25p post and packing, to:

the AUTOTRON company, Hixon, Stafford



Two flash units from Honeywell

SOLDERING PACK

Certainly an ideal kit to present as a gift to anyone, particularly at this time of the year, the new Adcola Products soldering kit contains all the essentials for simple soldering jobs. The kit contains an Invader soldering iron, a stand, solder wire, two spare soldering tips and an instruction card providing useful hints on successful soldering.

The soldering iron is thermally controlled to provide a constant heat level for ease of soldering. The standard soldering tip provided is rain diameter, but two replacement tips of kin and kin diameter are included to provide complete versatility for a 25W iron. The tips are merely inserted in the collar at the end of the iron to convert it from one task to another.

The stand provided with the kit features an integral sponge for cleaning excess solder from the tips and two holes to contain the spare tips. A spring holder is mounted on the base of the stand at an angle of about 45 degrees to take the iron when not in use.

The kit costs £3-99 and all the components are contained in a plastics tray featuring compartments for each component for safety in transit. The kit should be available from most d.i.y. shops, ironmongers or direct from Adcola Products Ltd., Adcola House, Gauden Road, London, S.W.4.

EMERGENCY LANTERN

With the forecast that power cuts are again probable this winter, it is wise to plan ahead for the eventuality and to have some form of emergency lighting handy.

MARKET PLACE

Items mentioned in this feature are usually available from electronic equipment and component retailers advertising in this magazine. However, where a full address is given, enquiries and orders should then be made direct to the firm concerned.



Adcola Products Soldering pack

A useful lamp is the "Safety Lantern" available from Harris Marketing. It is claimed to be virtually unbreakable, having a safe plastic dome which gives a 360 degree light and is powered by a 6V 996 battery.

It is particularly suitable around the home where there may be children or elderly people, for whom candles and other naked lights would be a danger, but it also makes a useful car, caravan or camping light.

Available direct from Harris Marketing. 16 Hillcroome Road, Sutton, Surrey, the lamp costs £1.85 plus 15p post and packing.

PHOTOGRAPHIC EQUIPMENT

Famous for their work in the computer field Honeywell have announced their entry into the photographic world with a range of electronic flash equipment, 35mm slide projectors and darkroom equipment.

Available in this country through Photo-Science Ltd. the range of equipment includes automatic flash units and slave flash units.

Also included in their range of products are four focusing projectors built-in preview models enable the see each slide on before it is projected to the audience.

Two of the flash units represent Honeywell's latest technological advancements in this field, which they call "strobo-eye" remote sensing. The sensor device is completely separated from the flash so that the light can be controlled from the camera or wherever the photographer desires.



Instant copying kit by Polaroid

These two flash units are described by Honeywell as the only system that will give accurate automatic exposure control of oncamera, off-camera and wall- or ceiling-bounce flash lighting.

Further particulars of the complete range of Honeywell photographic equipment can be obtained from Photo-Science Ltd., Charfleet Road, Carvey Island. Essex.

INSTANT COPY KIT

An inexpensive instant copy kit and accessories, providing a complete photographic copying system, is being introduced by **Polariod** (UK) Ltd. Both the copy kit and accessory unit are designed for use with any of three Polaroid instant picture cameras.

Ideal for making copies from a master design of printed circuit patterns to any required size, the Polaroid 105-1 kit gives a $\frac{1}{2}$: 1 reduction. The kit consists of a copy stand, close-up lens in mount, blue filter (for colour film used with tungsten light), polarising filter (for flash only). Colorpack 80 camera and a carrying case.

The complete kit costs £38.95; without a camera the kit retails at £24.

The 106 Instant Copy Kit accessory unit, comprising a copy stand and close-up lens for \(\frac{1}{3}\): 1 copies, will retail for £15.00.

EXTENSION LEADS

It has been brought to our attention that the price quoted for the Portapower cable reels mentioned in our September issue does not include the cost of cable.

We apologise for any inconvenience this may have caused.

SELECTION FROM OUR POSTBAG

Correspondents wishing to have a reply must enclose a stamped addressed envelope. We regret we are unable to guarantee a reply on matters not relating to articles published in the magazine. Technical queries cannot be dealt with on the telephone.

Correct perspective

Sir-Mr Hickman (Readout, November issue) has raised the question of component cost in Australia, a point certainly omitted from the first Report from Australia. Detailed costings of parts were not quoted, as indeed many other aspects of home construction were omitted, due mainly to space considerations; it was intended only as an introduction.

However, since the subject has been raised, the question of component cost must be placed in the correct perspective. In Sydney and Melbourne, the BC108, if we are to use this device as an example, can be bought at the rate of 6 for \$2.00 (16p each) including sales (purchase) tax. The figures as quoted by Mr Hickman may be applicable to South Australia, but it is indeed a half-truth to suggest that his situation applies throughout Australia.

The cost of components generally must, in any case, be viewed against the background of higher salaries here. It has been stated that, for professional occupations, salaries are very roughly 50 per cent

higher than in the U.K.

I would agree with your correspondent's comments regarding Australian conditions, particularly those in respect of the somewhat overglamorised publications for which Australia House is now famous.

Finally, Mr Hickman is under the illusion that I am Australian, and tend to avoid comparisons. I myself migrated from England some five years ago.

J. Waldie. Tamarama, N.S.W., Australia.

The defender

Sir-I would like to come to the defence of your constructional features in general and R. W. Coles'

P.E. Digi-Cal" in particular.
I doubt whether I will ever build the Digi-Cal. but the detailed way in which its operation is explained by the author has added measurably to my understanding of the logic functions involved. If such features are to be excluded because of a cost disadvantage compared with custom built devices, we amateurs will be deprived of much needed design know-how.

I have to confess that I jumped the gun by buying the Minitrons before the total cost of parts was revealed. Doubtless they will come

in handy one day—but it might be an idea if project-authors revealed the approximate cost of components at the outset and saved we impecunious constructors the embarrassment of having to abandon a project after buying a few of the items

> J. A. Burness. Herts.

Valuable learning

Sir-I noticed a number of letters in the October issue of P.E. that objected to the Digi-Cal on monetary and aesthetic grounds. The question was raised, why should you publish an article outlining the construction of a calculator when the basic i.c. is now available.

I can certainly construct a very simple calculator around one of the many calculator integrated circuits that are now available, but this teaches me nothing new about digital electronics. Even though I may not want to build the Digi-Cal. I have certainly been able to follow along with the author and now I have a better understanding of how these devices work. Maybe I have also picked up some new ideas on how to do things such as keyboard multiplexing and readout demultiplexing. That is as valuable as learning the basic operations of a calculator.

Many electronic hobbyists here in the USA are all too ready to put together a kit that teaches them nothing and tests only their ability to follow directions. Most of the electronic publications here cater to these individuals and that is why I subscribe to P.E. Keep up the good work

> Jonathan T. Titus, President. Titus Labs. Blacksburg. USA.

BACK NUMBERS WANTED

Anyone who can supply the undermentioned are asked to communicate directly with the reader.

We regret that back numbers of Practical Electronics can no longer be supplied. We will try to publish announcements of readers' requirements (without a guaranteed date) free of charge.

March-April 1971 Mr R. Brown, P.O. Box 926, Chingola, Zambia. July 1969 Mr K. Farrance, Charity Cottage, High Rougham, Bury St Edmunds, Suffolk.

February 1971
Mr. D. J. Hitchcock, 38 Deakin Street, Hampton 3188, Melbourne, Victoria, Australia.

December 1966 Mr. M. Robson, 8 Withipoll Street, Ipswich, Suffolk.

February, March, May 1971 Mr. T. J. Hsich, 39 Gold Jade Road, Kuching,

Mr T. J. Sarawak. January 1968 Mr G. Hart, 41 Waterlow Road, London N19 5NJ.

August 1966 Mr. R. A. Hume, 93 Sinclair Drive, Glasgow G42 9PU.

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November—December 1971 Mr. H. D. Westwood, 12 Cairn Walk, Crumlin, Co. Antrim, N. Ireland.

June 1969 Mr. J. E. Marshall, 4 Dellcott Close, Welwyn Garden City, Herts.

April—May 1971 Mr A. E. Thompson, 3 Uxbridge Court, Uxbridge Road, Kingston.

November 1971 Mr. G. C. Street, 21 Linton Crescent, Hastings, Sussex.

July 1970 to May 1971 Mr R. Konarek, 573 Daws Heath Road, Hadleigh, Benfleet, Essex.

May, June, July, Sept., Oct., Nov., Dec. 1969, January to April, August 1970 Mr J. Shapero, 64 Tixall Road, Birmingham, B28 ORS.

April-July 1971 Mr K. McKegney, 21 Queen Street, Chesterfield, Derbyshire, 540 45F. Up to Oct. 5.

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1N5408	3 A	1000	25p each

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Sinclair Project 60

Project 60 Stereo FM Tuner





Built and tested. Post free. £25

with phase lock-loop principle

Amongst the many advanced electronic features to be found in this remarkable stereo tuner, use of the phase lock loop principle ensures standards of audio quality better than from any other method of detection yet used. Varicap diode tuning, accurately formed printed circuit coils, an I.C. in the special stereo decoder section and switchable squelch circuit for silent tuning between stations contribute to the unsurpassed performance of this tuner, irrespective of price consideration. But the Project 60 FM Stereo Tuner is far from expensive – indeed, it offers fantastic value for money and will bring the thrill of stereo radio to many who previously may not have been able to afford it. The tuner may be used with any good system as well as Project 60, but if you use it with other Project 60 modules, you will find the matching front panels particularly impressive in appearance as well as function.

SPECIFICIATIONS

Number of transistors: 16 plus 20 in I.C. Tuning range: 87-5 to 108MHz. Sensitivity: 7µV for lock-in over full de-

Sensitivity: 7µV for lock-in over fu viation.

Squeich level: typically 20 μ V. Signal to noise ratio: +65dB.

Audio frequency response: 10Hz-15Khz (±1dB).

Total harmonic distortion: 0-15% for 30% modulation.

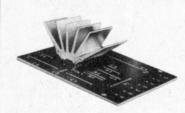
Stereo decoder operating level : $2\mu V$.

Cross talk: 40dB.

Output voltage: 2×150mV R.M.S. max. (typically 2×50mV, stereo)

Operating voltage: 25–30V DC at 100mA. Indicators: Stereo on: tuning.
Size: 93 × 40 × 207mm.

Super IC.12 Integrated circuit high fidelity amplifier



Having introduced Integrated Circuits to hi-ficonstructors with the IC.10, the first time an IC had ever been made available for such purposes, we have followed it with an even more efficient version, the Super IC.12, a most exciting advance over our original unit. This needs very few external resistors and capacitors to make an astonishingly good high fidelity amplifier for use with pick-up, F.M. radio or small P.A. set up, etc. The free 40 page manual supplied, details many other applications which this remarkable IC. make possible, It is the equivalent of a 22 transactions.

sistor circuit contained within a 16 lead DIL package, and the finned heat sink is sufficient for all requirements. The Super IC.12 is compatible with Project 60 modules which would be used with the Z.50 and Z.30 amplifiers. Complete with free manual and printed circuit board.

SPECIFICATIONS

Output power: 6 watts RMS continuous (12 watts peak). 6-80. Frequency Response: 5Hz to 100KHz±1d8. Total Harmonic Distortion: Less than 1%. (Typical 0-1%) at all output powers and frequencies in the audio band (28V). Load impedance: 3 to 15 ohms. Input Impedance: 250 Kohms nominal. Power Gain: 90d8 (1,000,000,000 times) after feedback. Supply Voltage: 6 to 28V. Quiescent current: 8mA at 28V. Size: 22 × 45 × 28mm including pins and heat sink.

Manual available separately 15p post free.

With FREE printed circuit board and 40 page manual.

£2.98 Post free



The easy way to buy and build Project 600

Project 605 is one pack containing: one P25.

Project 605 is one pack containing: one PZ5, two Z30's, one Steree 60 and one Masterlink. This new module contains all the input sockets and output components needed together with all necessary leads cut to length and fitted with neat little clips to plug straight on to the modules. Thus all soldering and hunting for the odd part is eliminated. You will be able to add further Project 60 modules as they become available adapted to the Project 605 method of connecting.

Complete Project 605 pack with comprehensive manual, post free £29.95

Everything you need to assemble a superb 30 watt high fidelity stereo amplifier without having to solder.

Sinclair Radionics Ltd, London Road, St. Ives, Huntingdonshire PE17 4HJ. Tel: St. Ives 64311

Practical Electronics December 1972

the world's most advanced high fidelity modules

Z.30 & Z.50 power amplifiers

Built, tested and guaranteed with circuits and instructions manual. 2.30 £4.48 2.50 £5.48

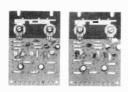
The Z.30 and Z.50 are of advanced design using silicon epitaxial planar transistors to provide unsurpassed standards of performance. Total harmonic distortion is an incredibly low 0.02% at 15w (8 Ω) and all lower outputs. Whether you use Z.30 or Z.50 amplifiers in your Project 60 system will depend on personal preference, but they are the same size and are intended for use principally with other units in the Project 60 range. Their performance and design are such, however, that Z.50s and Z.30 may be used in a far wider range of applications.

SPECIFICATIONS (2.50 units are interchangeable with 2.30s in all applications). — Power Outputs:

2.30 15 watts R.M.S. into 8 ohms using 35 volts: 20 watts R.M.S. into 3 ohms using 30 volts.

2.50 40 watts R.M.S. into 3 ohms using 40 volts: 30 watts R.M.S. into 8 ohms using 50 volts.

Frequency response: 30 to 300,000Hz±1dB. Distortion: 0.02% into 8 ohms. Signal to noise ratio: better than 70dB unweighted. Input sensitivity: 250mV into 100 Kohms (for 15w into 8Ω). For speakers from 3 to 15 ohms impedance. Size: 14 x 80 x 57mm.



Stereo 60 Pre-amp/control unit

Designed specifically for use on Project 60 systems, the Stereo 60 is equally suitable for use with any high quality power amplifier. Since silicon epitaxial planar transistors are used throughout, a really high signal-to-noise ratio and excellent tracking between channels is achieved. Input selection is by means of press buttons, with accurate equalisation on all input channels. The Stereo 60 is particularly easy to mount

SPECIFICATIONS—Input sensitivities: Radio — up to 3mV. Mag. p.u. 3mV: correct to R.I.A.A. curve ±1dB:20 to 25.000 Hz. Ceramic p.u. — up to 3mV: Aux — up to 3mV. Output: 250mV. Signal to noise ratio: better than 7ddB. Channel matching: within 1dB. Tone controls: TREBLE+12 to —12dB at 10kHz: BASS +12 to -12dB at 100Hz. Front panel: brushed aluminium with black knobs and controls. Size: 66 x 40 x 207mm.

Built, tested and quaranteed.

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A.F.U. High & Low Pass Filter Unit

For use between Stereo 60 unit and two Z.30s or Z.50s. The unit is very easily mounted and is unique in that the cut-off frequencies are continuously variable. As attenuation in the rejected band is rapid (12dB/octave), there is less loss of the wanted signal than has previously been possible. Amplitude and phase distortion are negligible. The A.F.U. is suitable for use with any other amplifier system. There are two filter sections - rumble (high pass) and scratch (low pass). H.F. cut-off (-3dB) variable from 28KHz to 5KHz. L.F. cut-off (—3dB) variable from 25Hz to 100Hz. Distortion at 1KHz (35V. supply) 0.02% at rated output. Operating voltage from 15 to 35V. Current 3mA. Size: 66 x 40 x 90mm

Built, tested and guaranteed.

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Power Supply Units

Designed specifically for use with the Project 60 system of your choice. Use PZ.5 for normal Z.30 assemblies and PZ.6 or PZ.8 where a stabilised supply is essential

PZ.5 30 volts unstabilised £4.98 PZ.6 35 volts stabilised £7.98 PZ.8 45 volts stabilised (less mains transformer) PZ.8 mains transformer





Typical Project 60 applications

System	The Units to use	together with	Units cost
Simple battery record player	Z.30	Crystal P.U., 12V battery volume control, etc.	£4.48
Mains powered record player	Z.30, PZ.6	Crystal or ceramic P.U. volume control, etc.	£9.45
12W. RMS continuous sine wave stereo amp. for average needs	2 x Z.30s, Stereo 60; PZ.5	Crystal, ceramic or mag. P.U., F.M. Tuner, etc.	£23.90
25W. RMS continuous sine wave stereo amp. using low efficiency (high performance) speakers	2 x Z.30s, Stereo 60; PZ.6	High quality ceramic or magnetic P.U., F.M. Tuner, Tape Deck, etc.	£26.90
80W. (3 ohms) RMS continuous sine wave de luxe stereo amplifier. (60W. RMS into 8 ohms)	2 x Z.50s, Stereo 60; PZ.8, mains transformer	As above	£34.88
Indoor P.A.	Z.50, PZ.8, mains transformer	Mic., guitar, speakers, etc., controls	£19.43

F.M. Stereo Tuner (£25) & A.F.U. (£5.98) may be added as required

Guarantee

If, within 3 months of purchasing any product direct from Sinclair Radionics Ltd., you are dissatisfied with it, you money will be refunded at once. Many Sinclair appointed Stockists also offer this same guarantee in co-operation with Sinclair Radionics Ltd, Each Project 60 module is tested before leaving our factory

and is guaranteed to work perfectly. Should any defect arise in normal use, we will service it at once and without any charge to you, if it is returned within two years from the date of purchase. Outside this period of guarantee a small charge (typically £1.00) will be made. No charge is made for postage by surface mail. Air Mail is charged at cost.

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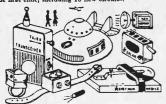
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DATA SHEETS	TAD100	1.97	CA3010A 0-69 C	0-47 C	A4052 A3053	1.80 1.48 0.52 0.48
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174p SGS TAA661B \$1-82	TAD110	1·97± 1·97±	CA3010A 0-69 C CA3011 0-92 C CA3012 1-11 1 CA3013 1-30 I CA3014 1-52 I CA3015 1-40 I	0-47 C 0-57 C 0-76 C 1-00 C 1-07 C 1-26 C	A4052 A3053 A3054 A3058 A3059 A3060AD	1.80 1.48 0.52 0.48 1.19 0.98 3.82 2.74 1.84 1.52 3.47 2.86
17±p SGS TAA661B \$1-32 TAA621 £2-03	TAD110 TAA700 TBA651	1.971 1.971	CA3010A 0-69 C CA3011 0-92 C CA3012 1-11 I CA3013 1-30 I CA3014 1-52 I CA3015 1-40 I CA3015A 1-82 I CA3016 2-61 S	3-47 C 3-57 C 3-76 C 1-00 C 1-07 C 1-26 C 1-15 C	A4052 A3053 A3054 A3058 A3059 A3060AD A3060BD	1.80 1.48 0.52 0.48 1.19 0.98 8.82 2.74 1.84 1.52 3.47 2.86 5.93 4.89
17†p SGS TAA661B \$1:32 TAA621 £2:03 All TTL IC's may	TAD110 TAA700 TBA651 be mixed to	1.971 1.971	CA3010A 0-69 0 CA3011 0-92 0 CA3012 1-11 1 CA3013 1-30 1 CA3014 1-52 1 CA3015 1-40 1 CA3015A 1-82 1 CA3016A 3-90 0 CA3016 0-88 0	0-47 C 0-57 C 0-76 C 1-00 C 1-07 C 1-26 C 1-15 1-50 C 2-15 3-22 C 0-72 C	A4052 A3053 A3054 A3058 A3059 A3060AD A3060BD A3060D A3060E	1.80 1.48 0.52 0.43 1.19 0.98 3.82 2.74 1.84 1.52 3.47 2.86 5.93 4.89 4.70 3.88 2.74 2.26
17†p SGS TAA661B \$1:32 TAA621 £2:03 All TTL IC's may	TAD110 TAA700 TBA651 be mixed to	1.971 1.971	CA3010A 0-89 (CA3011 0-92 (CA3012 1-11 1) CA3013 1-30 I CA3014 1-52 I CA3015 1-40 I CA3015 1-82 I CA3016 2-61 S (CA3018 0-88 (CA3018 1-19 (CA3018 0-94 (CA3018 0-	0-47 C 0-57 C 0-76 C 1-00 C 1-07 C 1-26 C 1-15 C 2-15 C 2-15 C 2-15 C 2-15 C 2-15 C	A4052 A3053 A3054 A3058 A3059 A3060 AD A3060 BD A3060 D A3060 D A3060 E A3062 A3064	1-80 1-48 0-52 0-43 1-19 0-98 3-82 2-74 1-84 1-52 3-47 2-86 5-98 4-89 4-70 3-88 2-74 2-26 2-97 2-45 1-42 1-17
17‡p SGS TAA661B \$1-32 TAA621 \$2:03 All TTL IC's may for quantity discoun 8 Pin TO-5 I.C. Hol 10 Pin TO-5 I.C. Hol 10 Pin TO-5 I.C. Hol 20 Pin TO-5 I.C. H	TAD110 TAA700 TBA651 be mixed to ts. ders, 20-25 ders, 20-35 ders, 40-57	1.97± 1.97± 23.50 ±1.69 qualify	CA3010A 0-89 (CA3011 0-92 (CA3012 1-11 1) CA3013 1-30 I CA3015 1-40 I CA3015 1-40 I CA3015 1-82 I CA3016A 3-90 (CA3018 0-88 (CA3018 0-94 (CA3019 0-94 (CA3019 0-94 (CA3019 0-94 (CA3019 0-94 (CA3019 0-94 (CA3011 0-94 (CA3019 0-94 (CA3011 0-9	0-47 C 0-57 C 0-76 C 1-00 C 1-07 C 1-26 C 1-15 C 2-15 C 2-15 C 2-15 C 2-15 C 2-15 C	A4052 A3053 A3054 A3058 A3059 A3060AD A3060BD A3060BD A3060D A3060E A3062 A3064 A3065	1.80 1.48 0.52 0.43 1.19 0.98 3.82 2.74 1.84 1.52 3.47 2.86 5.93 4.89 4.70 3.88 2.74 2.28 2.97 2.45 1.42 1.17 1.42 1.17
17‡p SGS TAA661B \$1-32 TAA621 £2-03 All TTL IC's may for quantity discoun 8 Pin T0-5 I.C. Hol 10 Pin T0-5 I.C. Hol 10 Pin T0-5 I.C. Hol 20 Pin T0-5 I.C. Hol	TAD110 TAA700 TBA651 be mixed to ts. ders, 20-25 ders, 20-35 ders, 40-57	1.97± 1.97± 23.50 ±1.69 qualify	CA3010A 0-89 C CA3011 1-11 CA3013 1-30 I CA3014 1-52 CA3015 1-40 I CA3015A 1-82 CA3016 2-81 CA3016 3-90 C CA3018 0-88 C CA3018 0-88 C CA3018 0-80 C CA3018 0-80 C CA3018 1-19 G CA3020A 2-01 I CA3020A 2-01 I CA3020A 2-01 I	0-47 C C C C C C C C C C C C C C C C C C C	A4052 A3053 A3054 A3058 A3059 A3060AD A3060BD A3060D A3060E A3062 A3064 A3065 A3065 A3066 A3067	1-80 1-48 0-52 0-43 1-19 0-98 3-82 2-74 1-84 1-52 3-47 2-86 5-93 4-89 4-70 3-88 2-74 2-28 2-97 2-45 1-42 1-17 1-42 1-17 2-61 2-15 2-72 2-24
17†p SGS TAA661B \$1:32 TAA621 £2:03 All TTL IC's may	TAD110 TAA700 TBA651 be mixed to ts. ders, 20-25 ders, 20-35 ders, 40-57	1.97± 1.97± 23.50 ±1.69 qualify	CA3010A 0-88 0 CA3011 0-82 0 CA3013 1-11 CA3013 1-30 1 CA3014 1-52 1 CA3015 1-40 1 CA3015 1-40 1 CA3016 2-61 3 CA3016 3-90 3 CA3018 0-86 0 CA3018 0-80 0 CA3018 1-19 0 CA3020 1-55 1 CA3021 1-90 1 CA3021 1-90 1 CA3021 1-90 1	0-47 C C C C C C C C C C C C C C C C C C C	A4052 A3053 A3054 A3058 A3059 A3060AD A3060BD A3060D A3060E A3062 A3062 A3064 A3065 A3066 A3067 A3068	1.80 1.48 0.52 0.48 1.19 0.98 3.82 2.74 1.84 1.52 3.47 2.86 5.93 4.89 4.70 3.88 2.74 2.26 2.97 2.45 1.42 1.17 1.42 1.17 2.61 2.15 2.72 2.24 3.01 2.48
17‡p SGS TAA661B \$1-32 TAA6621 \$2:03 TAA6221 \$2:03 All TTL 1C's may for quantity discoun 8 Pin TO-5 LC. Hol 10 Pin TO-5 LC. Hol 2 Pin TO-5 LC. Hol 8 Pin Dual-in-Line 14 Pin Dual-in-Line 16 Pin Dual-in-Line 17 TTL LOGICS	TAA700 TBA651 be mixed to ts. ders, 20.25 ders, 20.35 ders, 20.57 .C. Holders, C. Holders,	1.97± 1.97± 23.50 ±1.69 qualify \$0.20 \$0.20	CA3010A 0-68 0 CA3011 0-92 0 CA3011 1-11 1 CA3013 1-30 1 CA3014 1-52 1 CA3015 1-40 1 CA3015 1-40 1 CA3016 3-00 2 CA3016 3-00 2 CA3016 0-88 0 CA3018 1-19 0 CA3020 1-55 1 CA3020 1-55 1 CA3021 1-90 1 CA3021 1-90 1 CA3022 1-61 1 CA3023 1-55 1	0-47 C C C C C C C C C C C C C C C C C C C	A4052 A3053 A3053 A3058 A3059 A3060 AD A3060 BD A3060 BD A3060 BD A3060 E A3062 A3064 A3065 A3065 A3066 A3067 A3068 A3070 A3070	1-80 1-48 0-52 0-43 1-19 0-98 8-82 2-74 1-84 1-52 3-47 2-86 5-93 4-89 4-70 3-88 2-74 2-26 2-97 2-45 1-42 1-17 1-42 1-17 2-61 2-15 2-72 2-24 3-01 2-48 2-16 1-78 2-01 1-65
17‡p SGS TAA661B \$1-32 TAA6621 £2-08 All TTL IC's may for quantity discoun 8 Pin T0-5 I.C. Hol 12 Pin T0-5 I.C. Hol 12 Pin T0-5 I.C. Hol 12 Pin T0-5 I.C. Hol 14 Pin Dual-in-Line 16 Pin Dual-in-Line 17 TL LOGICS 1-24 25-99	TAA706 TBA651 be mixed to to test, 20-25 ders, 20-35 ders, 50-57 (.C. Holders, .C. Holders, .C. Holders,	1.97± 1.97± 23.50 21.69 qualify 20.20 20.17 20.20	CA3010A 0-69 0 CA3011 0-92 0 CA3011 1-11 1 CA3013 1-30 1 CA3014 1-52 1 CA3015 1-40 1 CA3015 1-40 1 CA3016 2-61 1 CA3016 1 1-50 1 1 CA3016 1 1-50 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	0-47 CC	A4052 A3053 A3054 A3058 A3058 A3060 AD A3060 BD A3060 BD A3060 BD A3060 A3062 A3062 A3065 A3065 A3067 A3067 A3067 A3071 A3072	1-80 1-48 0-52 0-43 1-19 0-98 3-82 2-74 1-84 1-52 3-47 2-86 5-93 4-89 2-74 2-26 2-97 2-45 1-142 1-17 1-42 1-17 1-43 1-17 1-44 1-21 1-74 1-14 1-14
17½p SGS TAA661B \$1-32 TAA6621 \$2-08 All TTL IC's may for quantity discoun 8 Pin T0-5 I.C. Hol 12 Pin T0-5 I.C. Hol 12 Pin T0-5 I.C. Hol 12 Pin T0-5 I.C. Hol 14 Pin Dual-in-Line 14 Pin Dual-in-Line 16 Pin Dual-in-Line 15 Pin	TAA700 TBA651 be mixed to ts. ders, 20-25 ders, 20-35 ders, 20-55 ders, 20-67 ders, 20-67 ders, 20-67 ders, 20-75	1.97± 1.97± 23.50 £1.69 qualify 20.20 £0.20 4.25-99 p. £p. 48.0-42	CA3010A 0-68 0 CA3011 0-92 0 CA3011 1-11 1 CA3013 1-30 1 CA3014 1-52 1 CA3015 1-40 1 CA3015 1-40 1 CA3016 3-00 2 CA3016 3-00 2 CA3016 3-00 2 CA3016 1-80 1 CA3016 1 CA30	0-47 0-57 0-76 0-00 0-107	A4052 A3053 A3054 A3058 A3058 A3060 AD A3060 AD A3060 BD A3060 E A3062 A3062 A3062 A3065 A3065 A3066 A3067 A3071 A3075 A3075 A3075 A3075	1-80 1-48 0-52 0-43 1-19 0-98 3-82 2-74 1-84 1-52 3-47 2-86 5-93 4-89 2-74 2-86 2-97 2-45 1-42 1-17 1-42 1-17 1-42 1-17 1-42 1-17 1-42 1-17 1-42 1-17 1-42 1-17 1-42 1-17 1-43 1-14 1-16 1-16 1-16 1-16 1-16 1-18 1-16 1-18
174p SGS TAA661B \$1-39 TAA6621 \$2-03 TAA6621 \$2-03 All TTL IC's may for quantity discoun 8 Pin T0-5 I.C. Hol 10 Pin T0-5 I.C. Hol 2 Pin T0-5 I.C. Hol 8 Pin Dual-in-Line 14 Pin Dual-in-Line 16 Pin Dual-in-Line 1 TTL LOGICS 1-24 25-99 50 8N7400 0-20 0-18 8N7401 0-20 0-18	TAA700 TBA651 be mixed to ts. ders, 20-25 ders, 20-25 ders, 50-57 LC. Holders, t. C. Holders, t. C. Holders, s.	1.97± 1.97± 1.97± 1.23.50 21.69 qualify 20.20 20.17 20.20 4.25-99 p. £p. 48.0-42 52.0-45	CA3010A 0-89 0 CA3011 0-92 0 CA3011 1-11 CA3013 1-30 1 CA3014 1-52 1 CA3015 1-40 1 CA3015 1-40 1 CA3015 1-40 1 CA3016 2-61 1 CA3016 A 3-90 2 CA3018 0-88 0 CA3018 0-88 0 CA3018 0-94 0 CA3020A 2-01 1 CA3020 1-55 1 CA3020 1 CA3	0-47 0-57 0-76 0-00 0-107	A4052 A3053 A3054 A3058 A3058 A3059 A3060 AD A3060 D A3060 D A3060 D A3060 D A3066 A3065 A3065 A3066 A3067 A3067 A3075 A3075 A3078 A	1-80 1-48 0-52 0-43 1-19 0-98 3-82 2-74 1-184 1-52 3-47 2-88 6-53 4-89 4-70 3-88 2-74 2-8 2-72 2-8 1-42 1-17 2-61 2-15 2-72 2-24 3-01 1-65 2-07 1-71 1-67 1-38 4-68 3-88 4-68 3-88
174p SGS TAA661B \$1-32 TAA621 \$2-03 All TTL IC's may for quantity discoun 8 Pin T0-5 I.C. Hol 10 Pin T0-5 I.C. Hol 12 Pin T0-5 I.C. Hol 8 Pin Dual-in-Line 14 Pin Dual-in-Line 16 Pin Dual-in-Line 17 Pin T0-5 I.C. Hol 18 Pin Dual-in-Line 18 Pin Dual-in-Line 19 In Dual-in-Line 19 In Dual-in-Line 19 In Dual-In-Line 18 Pin Dual-	TAD110 TAA700 TBA651 be mixed to te. ders, 20-25 ders, 20-35 ders, 20-57 .C. Holders, : C.C. Holders, : .C. Holders, : SN7422 00 SN7423 0 SN7423 0 SN7425 0	1.97± 1.97± 1.97± 23.50 21.69 qualify 20.20 425-99 p. £p 48.0.42 32.0.48 48.0.42 32.0.28	CA3010A 0-68 0 CA3011 0-92 0 CA3011 1-11 1 CA3013 1-30 1 CA3014 1-52 1 CA3015 1-40 1 CA3015 1-40 1 CA3015 1-40 1 CA3016 3-90 2 CA3016 3-90 2 CA3016 1-80 1 CA3018A 1-19 0 CA3018A 1-19 0 CA3020 1-55 1 CA3020 1-55 1 CA3020 1-55 0 CA3020 1-56 0	0-76 CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC	A4052 A3053 A3054 A3058 A3058 A3050 A3060 AD A3060 D A3060 D A3060 D A3060 D A3066 A3067 A3066 A3067 A3067 A3070 A	1-80 1-48 0-52 0-43 1-19 0-98 3-82 2-74 1-184 1-52 3-47 2-86 3-47
17½p SGS TAA661B \$1-32 TAA622 \$2-08 All TTL IC's may for quantity discoun 8 Pin T0-5 I.C. Hol 12 Pin T0-5 I.C. Hol 14 Pin Dual-in-Line 14 Pin Dual-in-Line 16 Pin Dual-in-Line 15 Pin Dual-in-Line 18 Pin	TAD110 TAA700 TBA651 be mixed to ts. ders, 20.25 ders, 20.35 ders, 20.57 .C. Holders, .C. Holders, .C. Holders, .S. N7422 SN7422 SN7422 SN7423 SN7426 SN7426 SN7427 SN7427 SN7427	1.97± 1.97± 1.97± 23.50 \$1.69 qualify 20.20 20.20 4.25-99 p. 29 4.25-99 p. 29 4.25-99 2.20 2.00 2.0	CA3010A 0-68 0 CA3011 0-92 0 CA3013 1-11 1 CA3013 1-30 1 CA3014 1-52 1 CA3015 1-40 1 CA3015 1-40 1 CA3015 1-40 1 CA3016 3-90 2 CA3016 3-90 1 CA3016 1-80 1 CA3016 1-80 1 CA3018 1-19 0 CA3020 1-55 1 CA3020 1-55 1 CA3020 1-55 1 CA3020 1-55 0 CA3033 1-56 1 CA303 1-5	0-476 C C C C C C C C C C C C C C C C C C C	A4052 A3053 A3054 A3058 A3068 A3069 A3060 D A3060 D A3060 D A3060 E A3062 A3062 A3065 A3065 A3065 A3067 A3066 A3067 A3070 A307	1-80 1-48 1-19 0-98 3-32 8-74 1-84 1-52 3-47 2-86 5-93 4-89 4-70 3-88 2-97 2-45 1-142 1-17 1-42 1-17 1-42 1-17 1-42 1-17 1-42 1-17 1-42 1-17 1-42 1-17 1-42 1-17 1-42 1-17 1-42 1-17 1-42 1-17 1-42 1-17 1-42 1-17 1-42 1-17 1-43 1-14 1-17 1-18 1-18 1-18 1-18 1-18 1-18 1-18
174p SGS TAA661B \$1-32 TAA6221 \$2-32 TTL LOGICS 1-24 \$25-39 SN7400 0.20 0.18 SN7401 0.20 0.18 SN7402 0.20 0.18 SN7404 0.20 0.18 SN7405 0.20 0.18 SN7406 0.20 0.18	TAA700 TBA651 be mixed to ts. ders, \$0.25 ders, \$0.35 ders, \$0.57 .C. Holders, : .C. Holders, : .C. Holders, : .SN7422 0 SN7423 0 SN7423 0 SN7426 0 SN7427 0 SN7428 0 SN7428 0 SN7428 0	1.971 1.971 1.971 2.3.50 21.69 qualify 20.20 20.17 20.20 4.25-99 p. 2p 48.042 52.0.41 80.42 48.042 32.0.28 48.042 52.044 80.42 52.04 80.42 52.04 80.42 52.04 80.42 52.04 80.42 52.04 80.42 52.04 80.42 52.04 80.42 52.04 80.42 52.04 80.42 52.04 80.42 52.04 80.42 52.04 80.42 52.04 80.42 52.04 80.42 52.04 80.42	CA3010A 0-68 0 CA3011 0-92 0 CA3011 1-11 1 CA3013 1-30 1 CA3014 1-52 1 CA3015 1-40 1 CA3015 1-40 1 CA3016 3-90 2 CA3016 3-90 2 CA3016 3-90 2 CA3016 3-90 2 CA3018 1-19 0 CA3020 1-55 1 CA3021 1-90 1 CA3021 1-90 1 CA3022 1-55 1 CA3023 1-55 1 CA3028 0-98 0 CA3028 0-98 0 CA3029 0-92 0 CA3028 0-93 0 CA3030 1-08 1 CA3030 1-08 0 CA3030 1-08 1 CA3030 1-08 0 CA3030 1-08 1 CA3031 1-52 1	0-47 C C C C C C C C C C C C C C C C C C C	A4052 A3053 A3054 A3058 A3068 A3060 AD A3060 BD A3060 BD A3060 BD A3060 E A3062 A3062 A3065 A3065 A3065 A3067 A3065 A3067 A3078 A307	1-80 1-48 0-52 0-43 1-19 0-98 3-32 2-74 1-84 1-52 3-47 2-86 5-93 4-89 4-70 3-88 2-97 2-45 1-42 1-17 1-42 1-17 1-42 1-17 1-42 1-17 1-42 1-17 1-42 1-17 1-43 1-18 1-187 1-38 1-50 1-57 1-187 1-38 1-50 1-57 1-180 1-48 1-50 1-48 1-50 1-57 1-80 1-48 1-180 1-48 1-180 1-48 1-180 1-48 1-180 1-48 1-180 1-48
174p SGS TAA661B \$1-32 TAA6221 \$2-32 TTL LOGICS 1-24 \$25-39 SN7400 0.20 0.18 SN7401 0.20 0.18 SN7402 0.20 0.18 SN7404 0.20 0.18 SN7405 0.20 0.18 SN7406 0.20 0.18	TAD110 TAA700 TBA651 be mixed to ts. ders, 20-25 ders, 20-35 ders, 20-37 .C. Holders, : .C. Holders, : .C. Holders, : .SN7422 OSN7423 OSN7423 OSN7426 OSN7426 OSN7427 OSN7428 OSN7427 OSN7428 OSN7428 OSN7428 OSN7423	1.97½ 1.97½ 2.3.50 21.69 qualify 20.20 20.20 4.25-99 p. 2p 48.0.42 52.0.41 20.21 48.0.42 34.0.42 50.0.41 20.21 48.0.42 34.0.42 34.0.42 34.0.42 34.0.42 34.0.42 34.0.42 34.0.42 34.0.42	CA3010A 0-68 0 CA3011 0-92 0 CA3011 1-11 1 CA3013 1-30 1 CA3014 1-52 1 CA3015 1-40 1 CA3015 1-40 1 CA3016 3-60 1 CA3016 3-60 1 CA3016 3-60 1 CA3016 3-60 1 CA3016 1-80 1 CA3017 1-80 1	0-47 C C C C C C C C C C C C C C C C C C C	A4052 A3053 A3054 A3058 A3069 A3060 A D A3060 B D A3060 B D A3060 A3060 A3062 A3062 A3062 A3065 A3067 A3067 A3075 A3075 A3075 A3075 A3078 A3080 A3080 A3082 A3082 A3083 A3083 A3083 A3083 A3083 A3083 A3083 A3083 A3083 A3083 A3083 A3083 A3083 A3083 A3083 A3083 A3083	1-80 1-48 0-52 0-43 1-19 0-98 3-82 2-74 1-84 1-52 3-47 2-86 5-93 4-89 4-70 3-88 2-74 2-86 2-97 2-45 1-142 1-17 1-42 1-17 1-42 1-17 1-42 1-17 1-43 1-11 1-67 1-38 1-48 3-36 2-80 2-81 0-94 0-78 0-58 0-48 1-36 1-18 1-80 1-48
174p SGS TA4681B \$1-32 TA4621 \$2-03 All TTL IC's may for quantity discoun 8 Pin TO-5 I.C. Hol 10 Pin TO-5 I.C. Hol 2 Pin TO-5 I.C. Hol 8 Pin Dusl-in-Line 1 16 Pin Dusl-in-Line 1 16 Pin Dusl-in-Line 1 18 Pin TO-5 I.C. Hol 2 Pin Dusl-in-Line 1 18 Pin Dusl-in-Line 1 10 Pin Dusl-in-Line 1	TAD110 TAA700 TBA651 be mixed to ts. ders, 20-25 ders, 20-35 ders, 20-37 .C. Holders, : .C. Holders, : .C. Holders, : .SN7422 SN7423 OSN7423 OSN7424 OSN7424 OSN7426 OSN7426 OSN7428 OSN7432 OSN7432 OSN7432 OSN7432 OSN7433 OSN7433	1.97½ 1.97½ 23.50 21.69 qualify 20.20 20.2	CA3010A 0-68 0 CA3011 0-92 0 CA3011 1-11 1 CA3013 1-30 1 CA3014 1-52 1 CA3014 1-52 1 CA3015 1-40 1 CA3015 1-40 1 CA3016 3-90 2 CA3016 3-90 2 CA3016 3-90 2 CA3018 1-19 0 CA3020 1-55 1 CA3030 1-04 0 CA3030 1-05 0 CA3031 1-52 1	1447 C 17-76 C C C 17-76 C C C 17-76 C C C C C 17-76 C C C C C C C C C C C C C C C C C C C	A4052 A3053 A3054 A3058 A3069 A3069 AD A3060 AD A3060 BD A3060 BD A3060 A3060 A3062 A3062 A3065 A3065 A3067 A3067 A3075 A3075 A3075 A3075 A3075 A3078	1-80 1-48 1-19 0-98 3-82 2-74 1-84 1-52 3-47 2-86 5-93 4-89 4-70 3-88 2-74 2-86 2-72 2-24 1-142 1-17 1-142 1-17 2-61 2-16 2-72 2-24 3-01 2-48 2-01 1-16 1-18 1-18 1-18 1-18 1-18 1-18 1-18
174p SGS TA4681B \$1-32 TA4621 \$2-03 All TTL IC's may for quantity discoun 8 Pin TO-5 I.C. Hol 10 Pin TO-5 I.C. Hol 2 Pin TO-5 I.C. Hol 8 Pin Dusl-in-Line 1 16 Pin Dusl-in-Line 1 16 Pin Dusl-in-Line 1 18 Pin TO-5 I.C. Hol 2 Pin Dusl-in-Line 1 18 Pin Dusl-in-Line 1 10 Pin Dusl-in-Line 1	TAD110 TAA700 TEA651 be mixed to te. ders, £0.25 ders, £0.57 .C. Holders,; C.C. Holders,; C.C. Holders, SN7422 OSN7423 OSN7425 OSN7426 OSN7426 OSN7427 OSN7427 OSN7430 OSN7430 OSN7430 OSN7430 OSN7433 OSN7433 OSN7433 OSN7438	1.97½ 1.97½ 1.97½ 0.23.50 21.69 qualify 20.20 4.25-99 p. £p 48.0.42 52.0.45 48.0.42 52.0.45 48.0.42 52.0.45 52.0.45 52.0.45 52.0.45 52.0.45	CA3010A 0-68 0 CA3011 0-92 0 CA3011 1-10 CA3013 1-30 1 CA3014 1-52 1 CA3015 1-40 1 CA3015 1-40 1 CA3015 2-41 1 CA3016 3-90 2 CA3016 3-90 2 CA3018 1-19 0 CA3018 1-19 0 CA3020 1-55 1 CA3020 1-55 1 CA3028 1-59 0 CA3028 0-58 0 CA3033 0-18 1 CA3028 1-80 1 CA3031 1-80 1 CA3031 1-80 0 CA3031 1-80 0 CA3033 1-85 1 CA3033 1-85 1 CA3033 1-85 1 CA3033 1-85 0 CA303 1-85 0 CA3033 1-85 0 CA303 1-85	1447 C 1477 C 14	A4052 A3053 A3054 A3058 A3059 A3069 A30609 A30609 A30600 A30600 A30600 A3060 A3065 A3065 A3065 A3065 A3065 A3065 A3075 A3075 A3075 A3075 A3075 A3075 A3075 A3078 A3078 A3079 A3079 A3078 A3085 A	1.80 1.48 0.52 0.43 1.19 0.98 3.82 2.74 1.84 1.52 3.47 2.86 5.93 4.89 4.70 3.88 2.74 2.26 2.97 2.45 1.42 1.17 2.61 2.15 2.72 2.24 3.01 2.48 2.01 1.65 2.07 1.71 1.46 1.21 1.47 1.88 1.90 1.57 1.80 1.83 1.90 1.57 1.80 1.48 1.90 1.57 1.80 1.48 1.90 1.57 1.80 1.48 1.90 1.57 1.80 1.48 1.80 1
174p SGS TAA661B \$1-32 TAA6621 \$2-03 All TTL IC's may for quantity discoun 8 Pln TO-5 I.C. Hol 10 Pln TO-5 I.C. Hol 12 Pln TO-5 I.C. Hol 12 Pln TO-5 I.C. Hol 16 Pln Dual-in-Line 16 Pln Dual-in-Line 17 Pln TO-8	TAD110 TAA700 TEA651 be mixed to te. ders, 20-25 ders, 20-35 ders, 20-57 .C. Holders,; L.C. Hol	1.97½ 1.97½ 1.97½ 23.50 21.69 qualify 20.20 20.20 20.17 20.20 4.25-99 9.59 4.8.042 5.20 4.8.042 5.20 4.8.042 5.20 4.8.042 5.20 6.8.042	CA3010A 0-68 0 CA3011 0-92 0 CA3011 1-11 0 CA3013 1-30 1 CA3014 1-52 1 CA3015 1-10 0 CA3015 1-10 0 CA3015 1-10 0 CA3016 3-00 0 CA3016 3-00 0 CA3018 1-10 0 CA3018 1-10 0 CA3020 1-55 1 CA3021 1-50 1 CA3023 1-50 1 CA3033 1-50 1 CA303	1-47 (1-47) (1-4	A4052 A3053 A3054 A3058 A3059 A3069 A30609 A30600 A30600 A30600 A30600 A3065 A3065 A3065 A3065 A3066 A3065 A3066 A3075 A3077 A3077 A3078 A3077 A3078 A3088 A3088 A3088 A3088 A3088 A3088 A3088 A3088 A3088 A3088 A3088	1.80 1.48 0.52 0.43 1.19 0.98 3.82 2.74 1.84 1.52 3.47 2.86 5.93 4.89 4.70 3.88 2.74 2.26 2.97 2.45 1.42 1.17 2.61 2.15 2.72 2.24 3.01 2.48 2.01 1.65 2.07 1.71 1.46 1.21 1.67 1.38 2.01 1.67 1.67 1.38 1.90 1.57 1.180 1.48 1.90 1.57 1.80 1.48 1.90 1.57 1.80 1.48 1.90 1.57 1.80 1.48 1.90 1.57 1.80 1.48 1.90 1.57 1.80 1.48 1.90 1.57 1.80 1.48 1.90 1.57 1.81 1.82 1.44 1.93 3.78 3.12 1.71 1.41 1.94 1.95 1.94 1.95 1.95 1.95 1.95 1.95 1.95 1.95 1.95
174p SGS TAA661B \$1-32 TAA6621 \$2-03 All TTL IC's may for quantity discoun 8 Pin To-5 I.C. Hol 10 Pin To-5 I.C. Hol 12 Pin To-5 I.C. Hol 12 Pin To-5 I.C. Hol 16 Pin Dual-in-Line 16 Pin Dual-in-Line 17 Pin To-8	TAD110 TAA700 TBA651 be mixed to te. ders, 20·25 ders, 20·35 ders, 20·37 .C. Holders, : C. Holders, : .C. Hold	1.97½ 1.97½ 1.97½ 23.50 \$1.69 qualify 20.20 20.20 20.17 20.20 4.25-99 48.0-42	CA3010A 0-68 0 CA3011 0-92 0 CA3011 1-11 1 CA3013 1-30 1 CA3014 1-52 1 CA3015 1-10 1 CA3015 1-10 1 CA3015 1-10 1 CA3016 3-00 2 CA3016 3-00 2 CA3016 3-00 2 CA3018 1-10 0 CA3018 1-10 0 CA3020 1-55 1 CA3021 1-50 1 CA3021 1-50 1 CA3023 1-55 1 CA3028 0-58 0 CA3030 1-55 1 CA3028 0-58 0 CA3030 1-58 1 CA3030 1-58 0 CA304 1-50 0 CA304 1-50 0 CA304 1-50 0	1-47 C C C C C C C C C C C C C C C C C C C	A4052 A3053 A3054 A3058 A3058 A3069 A3060 AD A3060 AD A3060 AD A3060 AD A3065 A3065 A3065 A3065 A3066 A3067 A3077 A3077 A3077 A3078 A3077 A3078 A3077 A3078 A3088	1-80 1-48 0-52 0-43 1-19 0-98 3-82 2-74 1-84 1-52 3-47 2-86 5-93 4-89 4-70 3-88 2-74 2-26 2-97 2-45 1-42 1-17 2-61 2-16 2-72 2-24 3-01 2-48 2-01 1-65 2-72 1-67 1-67 1-38 2-01 1-67 1-87 1-88 1-90 1-57 1-180 1-48 1-90 1-57 1-180 1-48 1-190 1-57 1-180 1-48 1-190 1-57 1-180 1-48 1-190 1-57 1-180 1-48 1-190 1-57 1-180 1-48 1-190 1-57 1-180 1-48 1-190 1-57 1-180 1-48 1-190 1-57 1-190 1-1
174p SGS TA4681B \$1-32 TA4681B \$1-32 TA4621 \$2:03 All TTL IC's may for quantity discoun 8 Pin To-5 I.C. Hol 10 Pin To-5 I.C. Hol 2 Pin To-5 I.C. Hol 8 Pin Dual-in-Line 1 16 Pin Dual-in-Line 1 16 Pin Dual-in-Line 2 Pin To-8 Pin Policy 1 Pi	TAD110 TAA700 TBA651 be mixed to ts. ders, 20-25 ders, 20-35 ders, 20-37, C.C. Holders, 1.C. Holders, 1.C. Holders, 1.C. Holders, 2.C. Holder	1.97½ 1.97½ 1.97½ 0.23.50 21.69 qualify 20.20 4.25-99 p. £p 48.0.42 52.0.45 48.0.42 52.0.45 48.0.42 52.0.45 52.0.45 52.0.45 52.0.45 52.0.45	CA3010A 0-68 (CA3011 0-92 (CA3011 0-92 (CA3011 1-11) (CA3013 1-80 1) (CA3014 1-55 1) (CA3014 1-55 1) (CA3015 1-80 1) (CA3015 1-80 1) (CA3016 1	1-47 1-	A4052 A3053 A3054 A3053 A3054 A3065 A3060 A3060 A3060 A3060 A3060 A3060 A3060 A3060 A3060 A3065	1-80 1-48 0-52 0-43 1-19 0-98 3-82 2-74 1-84 1-52 3-47 2-86 5-93 4-89 4-70 3-88 2-74 2-86 2-97 2-45 1-42 1-17 1-42 1-17 2-61 2-15 2-72 2-24 3-01 2-48 3-01 2-48 3-01 2-48 2-90 1-72 1-46 1-18 1-48 3-18 1-80 1-48 1-80 1

	LOT INA		ANSISTOR			COMPONENTS	GUARANTEEL
G301 G302	15p 2N2923 15p 2N2924	12p 2N4930 12p 2N4931	42.25 AF115 42.70 AF116	24p BC301 84p 1	7255 15p 7257 41p	· •	OTTKY ,
G303 \	25p 2N2925 30p 2N2926	12p 2N5172 2N5174	8p AF117 22p AF118	20p BC303 50p I	258 46 p	8N74800N 1-10 8N74814	4N 2-86 SN74L85N 4-0
G309 G344A	30p , Green 25p , Yellow	10p 2N5175 10p 2N5176	26p AF121	22p BC307 10p F	261 28 p	8N74864N 1-10 8N74L0:	N 0.60 SN74803N 1.1
3345B 371	25p ., Orange 15p 2N3053		48p AF125	20p BC307VI 10p E	264 £1.45 270 25 p	8N748112N 2-86 SN74L7-	IN 1.02 SN74820N 1.1
374 381	15p 2N3054 22p 2N3055	46p 2N5191 50p 2N5192	96p AF127	20p BC308A 9p F	271 21p 272 53p		
17 09	20p 2N3390 49p 2N3391	20p 2N5193	\$1.01 AF170	25p BC309 10p E	273 25p 27 4 28p	100 4	ENTIOMETERS and lin.
6	#1-40 2N 3391A	22p 2N5195	\$1.10 AF172 \$1.46 AF178	55p BC309B 10p E	'457 46p '458 57p	100. 7	DOUBLE GANGED 60
5.	75p 2N3392 75p 2N3393	18p 2N5245 18p 2N5457	48p AF179 80p AF180	50p BC327 24p E	'459 57p '821 \$2·10		DOOBEL CARGED TO
-	75p 2N3394 95p 2N3402	12p 2N5458 17p 2N5459	33p AF186 33p AF200	85p BC337 19p E	'821A £2.30 '828 92 p	DIODES &	RECTIFIERS
	\$1 2N3403 98p 2N3404	19p 3N128 84p 3N138	63p AF239 \$1.87 AF240	72p BCY30 85p H	'861 27 p '898 28 p		BAXI3 12ip BYZ13 25 BAXI6 12ip OA5 17i
A	20p 2N3405 20p 2N3414	27p 3N139 10p 3N140	41.86 AF279 76p AF280	54p BCY32 60p F	'W10 61p 'W11 61p	IN4148 7p AAZ13 10p	BAY18 1749 OA9 10 BAY31 749 OA10 234
SA.	75p 2N3415 75p 2N3416	10p 3N141 15p 3N142	69p AFY42 54p AF211	550 BCY34 35n F	W15 75p X13 23p	1N5145 \$2.37\frac{1}{2} AAZ15 12\frac{1}{2}p 1844 9p AAZ17 12\frac{1}{2}p	BAY38 25p OA47 8 BY100 17 p OA70 7
A	80p 2N3417 23.25 2N3570	£1.25 3N143	64p AL102 ~ 79p AL103	75p BCY38 40p E	X29 25p X30 25p	IS113 15p BA100 15p IS120 15p BA102 22ip	BY103 22 p OA78 10 BY122 87 p OA79 7
!	26p 2N 3571 34p 2N 3572	97p 3N153	74p A8Y26 74p A8Y27	80p BCY40 50p B	X37 30p		BY126 15p OA81 8 BY127 174p OA85 10
6 7	15p 2N3702 15p 2N3703	10p 3N 159 10p 3N 187	#1 ASY28 #1.80 ASY29	28p BCY43 15p E	X63 #2-48	[1813] 10p BA141 82 p	BY164 52 p OA90 7 BYX10 22 p OA91 7
3	25p 2N3704 29p 2N3705	10p 3N200 10p 3N201	\$2.07 A8Y50 \$1.05 A8Y55	20p BCY59 22p B	X68 30p X84 24p	18920 7p BA144 12ip	BYZ10 35p OA95 7 BYZ11 32p OA200 10
A	10p 2N 3706 12p 2N 3707	90p	A8Z21 AU103	55p BCY67 94p B	X85 29p X86 24p	18923 12p BA154 12ip	BYZ12 80p TIV307 60
	18p 2N3708 88p 2N3709	70p \ 90p	BC107 BC108	14p BCY71 22p B	X87 25p X88 20p	MAINS TRANSFORMERS "VARNIS	HED"
	80p 2N8710 21p 2N3711	90p 40050 90p 40251	78p BC109	14p BCY87 #3-47 B	X89 45p Y10 35p	2 amp Charger. Sec. 0-3-5-9-18V (1	P. & P. 22 p.)
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1	55p 2N3714	\$1.15 40360 \$1.28 40361	46p BC116	15p BCZ11 50p B	Y18 25p Y19 25p	6 anip (Douglas) MT107 Sec. tapping	gs from 6V to 50V \$7-47
	17p 2N 3716	\$1.30 40362	48p BC116A 44p BC117	21p BD116 75p B	Y20 50p Y29 40p	Various other Transformers ranging	from A to 5A in stock.
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2	16p 2N3782	#8-87 40410 #8-87 40411	53p BC135 42-00 BC136	11p BD137 55p B	Y64 41p Y75 40p	40512 #1-53 40432	\$1.87 2 400 46p 6 400 \$1.1
	20p 2N 3790	\$1.76 40467A \$1.90 40468A	69p BC137 44p BC138	15p BD139 71p B	Y76 22p Y77 24p	Economy Range Triacs TC4/10 (Pressfit) 4 amp 100 PIV	DIACS 65p MPT20 40
	28p 2N3792	\$2.06 40600 \$2.20 40601	69p BC140 67p BC141	34p BDY10 41.25 B	Y78 36p Y90 60p		75p MPT28 874 874p MPT32 874
	22p 2N3794 25p 2N3819	10p 40602 26p 40603	46p BC142 58n BC143	24p BDY17 41-50 B	Y39 30p X19 13p	ST2 DIAC	21p MPT36 87i
	25p 2N3820 90p 2N3828	47p 40604 50p 40636	56p BC144 £1·10 BC145	21p BDY19 41-97 B 21p BDY20 92p B	X20 14p		NITION SYSTEM
	24p 2N3824 20p 2N3826	75p 40673 28p AC107	56p BC147 85p BC148	10p BDY60 90p B	X21 20 p X26 34 p	COMPLETE VIT CO	
	35p 2N3854 30p 2N3854A	16p AC113 16p AC115	16p BC149 16p BC153	18p BDY62 75p B	X 27 34p X 28 25p	COMPLETE KIT ET	0.00 P. & P. 50p
1	27p 2N3855 21 2N3855A 21.10 2N3856	16p AC117 16p AC121	20p BC154 18p BC157	14p BD117 48p B	X29 47p X30 68p	SUB-MIN EI	LECTROLYTIC
	42-15 2N3856A	16p AC126 16p AC127	20p BC158 20p BC159	18p BF119 58p B 14p BF121 25p B	X 59 78 p X 60 54 p	Axial Lead Values (μF/V); 0-64/64; 1/40; 1-	6p each 8/25; 2.5/16; 2.2/63; 4/10; 4/40
	17p 2N3858 34p 2N3858A	160 AC128 160 AC141K	20p BC160 30p BC167B	18p BF125 25p B	K61 42p K76 15p	6·4/6·4; 6·4/25; 8/40; 10/16; 10/64; 25/25; 32/10; 32/40; 32/64; 40/16;	12-5/25; 16/40; 20/16; 20/64; 25/6-4
	30p 2N3859 70p 2N3859A	16p AC142K 16p AC151V	25p BC168B 14p BC168C	11p BF152 20p B	K77 20p K78 25p	80/16; 80/25; 100/6-4; 125/10; 200/6-	4.
1	60p 2N3860 40p 2N3866	16p AC152V 70p AC153	17p BC169B 22p BC169C	13p BF154 16p B	W70 28 p 724 20 p	THYRISTORS	MULLARD C280
A	40p 2N3877 40p 2N3877A	25p AC153K 26p AC154	25p BC170 20p BC171	11p BF158 15p Bi 18p BF159 27p Bi	725 15p 726 17p	PIV 50 100 200 300 400 1A 25p 27ip 37ip 40p 47ip	M/FOIL CAPACITORS
Α.	27p 2N3879	#1.91 AC176	18p BC172 20p BC182	11p BF160 28p Bi 10p BF161 35p Bi	727 15p 728 15p	4A 40p 45p 55p 60p 7A 87ip 92ip £1:12i	0.01, 0.022, 0.033, 0.047, \$p; 0.068 0.1, 4p each.
4.A.	30p 2N3900 37p 2N3900A	20p AC187K 21p AC188K	20p BC182L 26p BC183	10p BF163 20p Bi 9p BF166 35p Bi	738 15p 739 15p	TIC47 0.6A 200 PIV 58p Also 12A 100 PIV, 75p; 2N3525	0·15, 0·22, 0·33, 5p each. 0·47 9p
A	18p 2N3901 18p 2N3903	82p ACY17 20p ACY18	25p BC183L 15p BC184	9p BF167 18p B	751 25p 752 25p	at 85p.; 2N4444 \$1.91	0.68 11p 1µF 14p
A	20p 2N3904 20p 2N3905	17p ACY 19 21p ACY 20	20p BC184L 20p BC186	11p BF177 25p B8 25p BF178 25p B8	753 25p 754 30p	VEROBOARD 0-15 0-1 Matrix Matrix	1.5µF 21p 2.2µF 25p
) [20p 2N 3906 20p 2N 4036	90p ACY21 40p ACY22	18p BC187 18p BC204	25p BF179 30p B	756 79p 765 15p	2 in × 3 in 17p 23p	WIRE-WOUND RESISTORS
A	22p 2N 4037 20p 2N 4058	35p ACY28 12p ACY30	18p BC205 42p BC206	10p BF181 32p B8	778 40 p	31in × 31in 25p 25p	2.5 watt 5% (up to 270 ohm
A	25p 2N4059 11p 2N4060	90p ACY39 11p ACY40	55p BC207 17p BC208	10p BF183 40p B8	779 40p 7790 45p	3½in × 5in 30p 29p 5in × 17in (plain) 83p —	only), 7p. 5 watt 5% (up to 8-2k Ω only), 9p
A	12p 2N4061 15p 2N4062	11p ACY41	17p BC209	10p BF185 17p B	795A 9p	Vero Pins (bag of 36), 20p. Vero cutter, 45p; Pin insertion	10 watt 5% (up to 25k Ω only 10p.
	41p 2N4302 £1.20 2N4303	25p AD136V 38p AD140	81p BC211 96p BC212K 49p BC212L	10p BF195 15p C1	105 £2:25 1 58p	Tools (0-1 and 0-15 matrix) at 55p.	POTENTIOMETERS
1 1	18p 2N4918 12p 2N4914	80p AD142 87p AD143	49p BC212L 50p BC214L 45p BC236	12p BF196 15p C4 14p BF197 15p C4	4 . 15p	OPTOELECTRONICS	Carbon: Log. or Lin., less switch, 16p.
1	17p 2N 4915	95p AD149V	66p BC237	16p BF198 15p C4	6 25p	MINITRON 3015F 7-SEGMENT INDICATOR (SEE P.E. MARCH	Log. or Lin., with switch, 25p. Wire-wound Pots (3W), 38p.
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4.A.	2N4918 2N4919 2N4920	50p AD161 58p AD162	87p BC251 87p BC252	18p BF225J 19p D	N1 55p N3 62p	SIDE-VIEW NIXIE TUBES 75p. TIL-209 RED LIGHT EMITT-	PRESETS (CARBON)
БА В	88p 2N4921	60p AD161 }	69p BC257	9p BF238 22p G1	[111 45p	ING DIODE (TEXAS INST.) 35p	0-1 Watt 6p
A	18p 2N4922 2N4923 28p 2N4923	559 ADZ11 609 ADZ12	#1 50 BC258 #1 75 BC259	9p BF244 16p G1	[114 20p [115 50p	RESISTORS	0-2 Watt 6p 0-3 Watt 7p
7 7.A.	18p 2N 4927	£1 AF106	27p BC261 BC262	20p BF246 43p G1	[119 35p	Carbon Film watt 5%, lp, 1W & 1W are	SLIDER POTENTIOMETERS
^	2N 4928 1	11.80 AF109R 12.28 AF114	40p BC263 25p BC300	28p BF247 49p G1 24p BF254 14p G1	r535 20p	watt 5%, 1p. E24 series. watt 5%, 1p. W, 1W, 4 2W	SINGLE GANGED ONLY LIN: 1k, 2 5k, 20k, 25k, 100k
3					-	w M/O 2% 4p. are E12 series.	250k, 1M.
	Matchi sing 13p per order	. Europe 25p. (io transistors only) Commonwealth (Al	r) Letter 65p (Min.). Parcel	1:69 (Min.)	1 watt 10%, 24b.	LOG; 5k, 10k, 25k, 100k, 500k
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SU4G	.81	30FL14	-68	EBF80	-32	EY86	.29	PCL85	-38	UBF80	-34
V4G	-35	30L1	.29	EBF83	-39	EY87	.29	PCL86	.38	UBF89	-32
Y3GT	.84	30L15	-70	EBF89	-29	EZ40	-48	PCL88	-68	UCC84	-82
5Z4G	-35		.67	ECC81	.17	EZ41	.43	PCL800	-89	UCC85	.85
3/30L2	-54	30P4	-65	ECC82	.20	EZ80	.22	PCL805	.38	UCF80	-31
SAL5	-11	30P12	-69	ECC83	-35	EZ81	.28	PENA4	-77	UCH42	-58
SAM6	.13	30P19	-65	ECC85	-84	EZ90	-25	PEN36C		UCH81	-82
SAQ5	.22	30PL1	-60	ECC804	-54	QZ30	-84	PFL200	.52	UCL82	-32
SAT6	.20	30PL13	.89	ECF80	-31	GZ32	·40	PL36	-49	UCL83	.55
BAU6	.20	30PL14	·68	ECF82	-26	KT41	-77	PL81	-44	UF41	-52
BA6	.20	35L6GT	-45	ECH35	-55	KT61	.55	PL81A	-47	UF89	-30
BE6	.21	35W4	.25	ECH42	-59	KT66	-78	PL82	.31	UL41	-58
8BJ6	-41	35Z4GT	.25	ECH81	-29	LN319	-63	PL83	.88	UL84	-80
BW7	-52	50CD6G	.68	ECH83	-40	LN 329	-72	PL84.	-80	UM84	-22
3F14	-40	307	-49	ECH84	-36	LN 339	-65	PL500	.68	UY41	-38
3F23	-68	AC/VP2	.77	ECL80	-85	N78	-87	PL504	-68	UY85	.25
F25	-53	B349	.70	ECL82	-81	P61	· 40	PM84	-33	VP4B	.77
J7G	.24	B729	-54	ECL86	-35	PABC80	-84	PX 25	.95	W77	-48
K7G		CCH35	-67	EF39	-38	PC86	-47	PY32	-52	277	-22
K8G	.17	CY31	.30	EF41	-60	PC88	-47	PY33	-52	Transist	
SQ7G	.85	DAF91	.22	EF80	.28	PC96	-42	PY81	.25	AC107	.17
SL7GT	.80	DAF96	.36	EF85	-28	PC97	-86	PY82	.25	AC127	.18
38N7.GT	-80	DF91	.16		1.30	PC900	.29	PY83	-26	AD140	.37
3V6G	.28	DF96	-36	EF89	-26	PCC84	-29	PY88.	.38	AF115	.20
SV6GT	-28	DH77	.20	EF91	.13	PCC85	.28	PY800	.34	AF116	.20
3X4	.28	DK32	.88	EF92	-27	PCC88	.38	PY801	.84	AF117	.20
X5GT	.28	DK91	.28	EF98	-65	PCC89	·45	R19	.30	AF 125	-17
10P13	.58	DK92	-50	EF183	.28	PCC189	·48	R20	.70	AF127	.17
L2AT7	.17	DK96	.45	EF184	.31	PCC805	-70	U25	.73	OC26	.21
2AU7		DL35	.40	EH90	-84	PCF80	-28	U26	.70	OC44	-15
L2AX7	.22	DL92	.26	EL33	-55	PCF82	.33	U47	.73	OC45	-15
19BG6G	.80	DL94	-47	EL34	-45			U49	.70	OC71	.15
20F2	-67	DL96	.38	EL41	-54	PCF86	-46	U52	.31	OC72	-15
20P3	.75	DY86	.24	EL84	.23	PCF800	.58	U78	.24	OC75	-15
25L6GT	.19	DY87	.24	EL90	-26	PCF801	-28	U191	.68	OC81	-11
25U4GT	-57	DY802	.33	EL95	-33	PCF802	.40	U193	-42	OC81 D	.15
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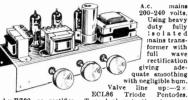
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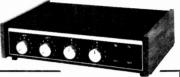
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AC107 AC113 AC115 AC117K AC122 AC128 AC128 AC128 AC132 AC134 AC137 AC141 AC141 AC142 AC141 AC142 AC155 AC156 AC156 AC166 AC166 AC167 AC168 AC177 AC168 AC177 AC168 AC177 AC181 AC178 AC178 AC178 AC181	0-20 0-20 0-20 0-20 0-12 0-17 0-17 0-14 0-14 0-14 0-14 0-15 0-20 0-20 0-20 0-20 0-20 0-20 0-20 0-2	AD162 AD161 AD161 AD161 AD161 AD161 AF114 AF115 AF116 AF117 AF118 AF125 AF127 AF129	MP) 0·55	BC148 BC149 BC150 BC151 BC152 BC152 BC153 BC158 BC158 BC158 BC158 BC169 BC167 BC168 BC171 BC173 BC173 BC173 BC174 BC173 BC174 BC178 BC178 BC182 BC182 BC182 BC182 BC182 BC182 BC182 BC183 BC184 BC184 BC184 BC184 BC184 BC184 BC185 BC186 BC187 BC187 BC187 BC188	0.10 0.12 0.20 0.17 0.28 0.12 0.12 0.12 0.12 0.14 0.14 0.22 0.14 0.24 0.14 0.22 0.12	BD137 BD138 BD139 BD145 BD178 BD178 BD178 BD178 BD188 BD188 BD188 BD189 BD199 BD199 BD199 BD199 BD199 BD197	0 - 45 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	BF188 BF195 BF195 BF197 BF202 BF258 BF258 BF258 BF263 BF272 BF271 BF271 BF271 BF271 BF273 BF273 BF273 BF274 BFX85 BFX86	0 · 40 · 12 · 0 · 14 · 0 · 12 · 0 · 14 · 0 · 15 · 0 · 14 · 0 · 45 · 0 · 85 · 0 · 85 · 0 · 85 · 0 · 85 · 0 · 85 · 0 · 85 · 0 · 22 · 0 · 20 · 24 · 0 · 20 · 20 ·	OC19 OC29 OC24 OC24 OC26 OC28 OC28 OC28 OC36 OC41 OC45 OC70 OC71 OC72 OC74 OC75 OC81 OC81 OC81 OC82 OC82 OC84 OC10 OC82 OC84 OC10 OC81 OC81 OC81 OC81 OC81 OC81 OC81 OC81	0 · 35 0 · 63 0 · 42 0 · 38 0 · 50 0 · 50 0 · 50 0 · 12 0 · 10 0 · 12 0 · 15 0 · 10 0 · 12 0 · 15 0 · 10 0 · 15 0 ·	2G371 2G371B 2G373 2G374 2G377 2G378 2G381 2G417 2C417 2N388 42N404 42N527 2N998 2N999 2N706 42N706 2N707 2N718 42N717 2N718 42N717 2N718 42N727 2N718 42N727 2N718 42N727 2N718 42N727 2N718 42N727 2N718 42N727 2N718 42N727 2N718 42N727 2N718 42N727 2N718 42N727 2N718 42N727 2N718 42N727 2N718 42N727 2N718 42N727 2N718 42N727 2N744 2N744 2N744 2N744 2N744	0 · 16 · 10 · 10 · 10 · 10 · 10 · 10 · 1	2N2219 2N2220 2N2221 2N2222 2N2368 2N2369 2N2369 2N2369 2N2369 2N2711 2N2712 2N2714 2N2904 4N2906 4N2906 2N2906	0 24 0 24 0 27 0 21 0 21 0 21 0 21 0 21 0 21 0 21 0 21	2N3054 2N3056 2N3391 2N3391 2N3393 2N3393 2N3394 2N3395 2N3403 2N3406 2N3416 2N3416 2N3416 2N3416 2N3417 2N3525 2N3705 2N3905 2N	0 46 0 50 0 14 0 16 0 14 0 14 0 17 0 21 0 21 0 21 0 21 0 21 0 21 0 22 0 42 0 42 0 15 0 10 0 11 0 0 11 0 0 11 0 0 0 0 0 0 0 0	2N4059 2N4060 2N4060 2N4060 2N4286 2N4286 2N4286 2N4289 2N4290 2N4291 2N4292 2N4293 2N4293 2N4293 2N4293 2N4293 2N4293 2N4293 2N4293 2N4293 2N5458 2N548	0 · 10 0 · 12 0 · 12 0 · 17 0 · 12 0 · 32 0 · 40 0 · 55 0 · 42 0 · 56 0 · 42 0 · 56 0 · 66 0 · 67 0 · 70 0
AC187 K AC188 AC188 K	0·20 0·22	ASZ21 BC107 BC108	0.40	BC208 BC209	0·11 0·12	BF127 BF152	0 · 50 0 · 55	BSY29 BSY38	0.15	OC202 OC203	0·28 0·25	2N918 2N929	0 · 30 0 · 21	2N3011 2N3053	0·14 0·17	2N3906 2N4058	0 · 27 0 · 12	40361 40362	0 40 0 45
ACY17	0 · 20 0 · 25	BC109	0 · 09 0 · 10	BC212L BC213L	0·11 0·11	BF153 BF154	0 · 45 0 · 45	BSY39 BSY-0	0·18 0·28	OC204 OC205	0·25 0·35	2N930 2N1131	0·21 0·20						
ACY18 ACY19	0.20	BC113 BC114	0·10 0·15	BC214L BC225	0·14 0·25	BF155 BF156	0 · 70 0 · 48	BSY41 BSY95	0 · 28 0 · 12	OC309 P346A	0 40	2N1132 2N1302	0·22 0·14		DIOI	ES AND	RECTIE	TERS	
ACY20	0.20	BC115	0.15	BC226	0.35	BF157	0.55	BSY95A	0.12	P397	0.42	2N1303	0.14	AA119	0.08	BY133	0 · 21	OA10	0.35
ACY21 ACY22	0 · 20 0 · 16	BC116 BC117	0·15 0·15	BCY30 BCY31	0 24	BF158 BF159	0 · 55 0 · 60	Bul05 C111E	2 · 00 0 · 50	OCP71 ORP12	0.43	2N1304 2N1305	0·17 0·17	AA120 AA129	0.08	BY 164 BY X 38/3	0·50 30	OA47 OA70	0·07 0·07
ACY27 ACY28	0·18 0·19	BC118 BC119	0·10 0·30	BCY32	0.80	BF160 BF162	0-40	C400 C407	0 · 30 0 · 25	ORP60	0.40	2N1306	0.21	AAY30	0.09	DRETA	0.42	OA79	0.07
ACY29	0.35	BC119	0.80	BCY33 BCY34	0 - 22	BF163	0.40	C424	0.20	ORP61 ST140	0 · 40 0 · 12	2N1307 2N1308	0.21	AAZ13 BA100	0·10 0·10	BYZ10 BYZ11	0.35	OA81 OA85	0.07
ACY30	0.28	BC125	0.12	BCY70	0.14	BF164	0.40	C425	0.50	ST141	0.17	2N1309	0 23	BA116	0.21	BYZ12	0.30	OA90	0.06
ACY31 ACY34	0·28 0·21	BC126 BC132	0·18 0·12	BCY71 BCY72	0·18 0·14	BF165 BF167	0·40 0·22	C426 C428	0.35	T1843 UT46	0 30	2N1613 2N1711	0 - 20	BA126 BA148	0·22 0·14	BYZ13 BYZ16	0 - 25	OA91 OA95	0.06
ACY35	0.21	BC134	0.18	BCZ10	0.20	BF173	0 22	C441	0.30	2G301	0.09	2N 1889	0.32	BA154	0.12	BYZ17	0.35	OA200	0.08
ACY36 ACY40	0 - 28	BC135 BC136	0·12 0·15	BCZ11 BCZ12	0·25 0·25	BF176 BF177	0 · 35 0 · 35	C442 C444	0.30	2G302 2G303	0·19 0·19	2N1890 2N1893	0·45 0·37	BA155 BA156	0.14	BYZ18 BYZ19	0.35	OA202 SD10	0·07 0·05
ACY41	0.18	BC137	0.15	BD121	0.60	BF178	0.30	C450	0.22	2G304	0 . 24	2N2147	0.72	BY100	0.15	CG62		8D19	0.05
ACY44 AD130	0.35	BC139 BC140	0-40	BD123 BD124	0 · 65 0 · 60	BF179 BF180	0.30	MAT100 MAT101	0 19	2G306 2G308	0 · 40 0 · 35	2N2148 2N2160	0 - 57	BY101 BY105	0·12 0·17	(Eg) OA9	0.05	IN34 1N34A	0.07
AD140	0.48	BC141	0.30	BD131	0.50	BF181	0.30	MAT120	0.19	2G309	0.35	2N2192	0 35	BY114	0.12	CG651		1N914	0.06
AD142 AD143	0 · 48 0 · 38	BC142 BC143	0.30	BD132 BD133	0.60	BF182 BF183	0:40	MAT121 MPF102	0 - 20	2G339 2G339A	0.20	2N2193 2N2194	0·35 0·35	BY126 BY127	0 · 14 0 · 15	(Eq) OA7 OA79	0.06	1N916 IN414B	0 · 06
AD149	0.50	BC145	0.45	BD135	0.40	BF184	0 25	MPF104	0.37	2G344	0.18	2N2217	0 - 22	BY128	0.15	OA78	0.35	18021	0.10
AD161	0 - 33	BC147	0.10	BD136	0.40	BF185	0.30	MPF105	0.37	2(1345	0.16	2N2218	0 - 20	BY130	0.16	OASSL	0.21	18951	0.06

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200	0.05	0.09	0.06	0.14	$0 \cdot 20$	0.24	1.00	
400	0.06	0.13	0.07	0.20	0.27	$0 \cdot 37$	$1 \cdot 25$	
600	0.07	0.16	0.10	0.25	0.34	0.45	1.86	
800	0.10	0.17	0.11	0.25	0.37	0.55	2.00	
1000	0.11	0.25	0.14	0.30	0.46	0.63	2.50	
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$UIC30 = 12 \times 7430$	0.50	UIC74 = 8 × 7474	0.50	UIC151 = 5 × 74151	0.50
UIC40 = 12 × 7440	0.50	UIC75 = 8 × 7475	0.50	UIC154 = 5 × 74154	0.50
$UIC41 = 5 \times 7441$	0.50	UIC76 = 8 × 7476	0.50	UIC193 = 5 × 74193	0.50
$UIC42 = 5 \times 7442$	0.50	$UIC80 = 5 \times 7480$	0.50	$U1C199 = 5 \times 74199$	0.50
$UIC43 = 5 \times 7443$	0.50	$UIC81 = 5 \times 7481$	0.50		
$UIC44 = 5 \times 7444$	0.50	$UIC82 = 5 \times 7482$	0.50	UICXI = 25 Assorte	ed
$UIC45 = 5 \times 7445$	0.50	UIC83 = 5 × 7483	0.50	74'8	1.50

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SN 7401	0.15	0.14	0-12	SN7490	9 47	0 44	0.58
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SN7404	0.15	0114	0-12	SN7493	0-67	0 44	0.58
SN7405	0.15	0.14	0 12	5N7494	0.77	0.74	0.40
SN7406	0.35	0.31	0 28	SN7495	0.77	0.74	0.60
SN7407	0.35	0.31	0 - 28	SN7496	0-87	0.84	8.78
SN 7408	0.18	0.17	0-16	SN74100	£1 45	£1 40	£1-55
SN7409	0-18	0 17	0.16	SN74104	0.97	0.94	0.08
SN7410	0-15	0:14	0 12	SN74105	0.97	0.94	RS- 0
SN7411	0 25	0 24	0.23	SN74107	0.40	0 - 30	0.36
SN7412	0:35	0.31	0 20	SN74110	0.55	0 53	0 -50
SN7413	0 - 29	0:36	0-24	SN74111	£1-25	£1:15	£1:10
SN7416	0.43	0.40	0.30	SN74118	£1 40	0.95	0.90
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SN7423	0 - 50	0 48	0.45	SN74123	£2 80	€2.70	€2 40
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SN7447	£1 00	0.97	8-95	SN74166	£3 50	£3 25	£3 ·00
SN7448	£1 00	0.97	0.95	SN74174	€2:30	£2 20	£2 ·10
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SN7476	8-40	0 39	0.38	SN74193	£2 00	£1 -80	£1 ·75
SN7480	0.67	0.64	0.58	SN74194	£2 70	£2 40	£2 50
SN7481	£1:20	£1 15	£1 10	SN74195	£2-00	£1 90.	£1 00
SN7482	0.67	0.86	0.85	SN74196	£1 90	£1 70	£1 60
SN7483	£1 10	£1 05	0.45	SN74197	(1-00	£1:70	£1.40
SN7484	£1 00	0.95	0.90	SN74198	45 50	£5 00	£4 -50
SN7485	£3 60	43 50	£3 40	SN74199	£5 ·50	£5 00	£4-50
SN7486	0.32	0:31	0.30				

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Type No.	1-24	Price 25-99	100 up
BP201C \$1.201C	68p	58p -	45n
BP701C S1 701C	68p	50p	45p
BP702(S1 702(68p	50p	45p
BP702-72702	53o	45p	40p
BP70972709	36p	34p	30 p
BP709P-4A7090	36p	34p	30p
BP710-72710	44p	42p	40p
BP711-4-A711	45p	430	40 _D
BP741-72741	75p	60p	50p
µ.A703€ —µ.A703€	28 ₀	26p	24p
TAA263-	70p	60p	55p
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TAA350	170p	158p	150p
S.G.S. EA1000 243	· · op	1.300	Loop

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Туре		Price	
No.	1-24	25-99	100 up
BP930	12p	11p	10p
BP932	13p	12p	Hp
BP933	13p	12p	Hp
BP935	13p	12p	Hp
HP936	13p	12p	11p
BP944	13p	12p	11p
BP945	25p	24p	22p
R P946	12p	Hp	10p
BP948	25p	24p	22p
BP951	65p	60p	55p
BP962	12p	lip	10p
B P9093	40p	36p	35p
BP9094	40p	36p	35p
BP9097	40p	36p	35p
HP9099	40p	36p	35p

Devices may be mixed to qualify for quantity price. Larger quantity price on application (DTI 930 Series only)

NUMERICAL INDICATOR TUBES



MODEL	CD66	GR116	3015F Minitron
Anode voltage (Vdc)	170min	175min	ō
Cathode Current (mA)	2.3	14	8
Numerical Height (mm)	16	13	9
Tube Height (mm)	47	32	22
Tube Diameter (mm)	19	13	12 wide
I.C. Driver Rec.	BP41 or 141	BP41 or 141	BP47
PRICE EACH	\$1.70	£1-55	\$1.90

All indicators 0.9 + Decimal point. All side viewing. Full data for all types available on request.

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Price each

Epoxy TO-5 case 1-24 25-99 100 up nL900 Buffer 85p 88p 87p uL914 Dual 2i/p 85p 88p 27p uL923 J-K flip-flop 50p 47p 45p Date and Circuits Booklet for IC's Price 7p.

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★ Load—3, 4, 8 or 16 ohms.

★ Distortion-better than .1% at

★ Signal to noise ratio 80dB. Tailor made to the most stringent specifications using top quality components and incorporating the latest solid state circuitry and ALSO was conceived to fill the need for all your A.F. amplification needs. FULLY BUILT — TESTED — GUARANTEED.

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£3.25p each

★ Supply voltage 10-35



Volts.

STABILISED POWER **MODULE SPM80**

AP80 is especially designed to power 2 of the AL50 Amplifiers, up to 15 watt (r.m.s.) per channel simultaneously. This module embodies the latest components and circuit techniques incorporating complete short circuit protection. With the addition of the Mains Transformer MT80, the unit will provide outputs of up to 1.5 amps at 35 voits. Size: 33mm × 105mm × 30mm.

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TRANSFORMER BMT80 £1.95 p. & p. 25p.

STEREO PRE-AMPLIFIER TYPE PA100

Built to a specification and NOT a price, and yet still the greatest value on the market, the PA100 stereo pre-amplifier has been conceived from the latest circuit techniques. Designed for use with the AL50 power amplifier system, this quality made unit incorporates no less than eight silicon planar transistors, two of these are specially selected low noise NPN devices for use in the input stages.

Three switched stereo inputs, and rumble and scratch filters are features of the PA100, which also has a STEREO/MONO switch, volume, balance and continuously variable has a silicon selection.

bass and treble controls.

SPECIFICATION



Frequency Response Harmonic Distortion Inputs: 1. Tape Head 2. Radio, Tuner 3. Magnetic P.U.

 $20\text{Hz} - 20\text{KHz} \pm 1\text{dB}$ better than 0·1%
1·25 mV into 50K Ω
35 mV into 50K Ω
1·5 mV into 50K Ω All input voltages are for an output of 250mV. Tape and P.U. inputs equalised to RIAA curve within \pm 1dB. from 20Hz to 20KHz.

Bass Control Bass Control Treble Control Filters: Rumble (High Pass) Scratch (Low Pass)

Input overload Supply Dimensions

± 15dB at 20Hz ± 15dB at 20KHz 100Hz 8KHz better than - 85dB + 26dB + 35 volts at 20mA 292mm × 82mm ×

mm × 35mm ONLY £11.95

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RESISTORS

tW lskra high stability carbon film—very low noise—capless construction tw Mullard CR25 carbon film—very small body size 7-5 x 2-5mm 2% ELECTROSIL TR8

Power			Values	Price	:
Watts	Tolerance	Range	available	1-99	100+
4	5%	4-7Ω=2-2MΩ	E24	l p	0-8p
į	10%	$3.3M\Omega = 10M\Omega$	E12	Ιp	0-8p
Į.	2%	10Ω-1MΩ	E24	3·5p	3p
į	10%	10-3.90	E12	I p	0.8p
į.	5%	4·7Ω=IMΩ	E12	l p	0 8p
4	10%	10-100	£12	6р	5-5p

Quantity price applies for any selection. Ignore fractions on total order.

DEVELOPMENT PACK

0.5 watt 5% Iskra resistors 5 off each value 4.70 to IMO. E12 pack 325 resistors £2.40, E24 pack 650 resistors £4.70.

POTENTIOMETERS

Carbon track $5k\Omega$ to $2M\Omega$, log or linear (log $\frac{1}{2}W$, lin $\frac{1}{2}W$). Single, 12p. Dual gang (stereo), 40p. Single D.P. switch 24p.

SKELETON PRESET POTENTIOMETERS

Linear: 100, 250, 500 and decades to SMD. Horizontal or vertical P.C. mounting (0.1 matrix).
Sub-miniature 0.1W, 5p each. Miniature 0.25W, 6p each.

TRANSI	STOR	S					
		BC108	10p	8FY51	22p	OCP71 40p	2N3703 12p
ACI26 I	2p	BC109	10p	BFY52	22p	ORPI2 50p	2N3704 13p
ACI27 I	2p	BC147	10p	BSY 56	32p	2N2369 16p	2N3705 12p
		BCI48	13p	OC26	45p	2N2646 60p	2N3706 Hp
ACI31 I	2p	BC149	13p	OC28	45 p	2N2926R 9p	2N3707 12p
		BC157	13p	OC35	45p	2N2926O 9p	2N3708 10p
AD140 5	Op q	BC 58	13p	OC42	12p	2N2926V 9p	2N3709 11p
AD161 3	3p	BC159	13p	OC44	12p	2N2926G	2N3710 11p
AD162 3	бр	BDI31	75p	OC45	12p	10p	2N3711 11p
		BD132	75p	OC70	12p	2N3054 58p	2N4062 12p
		BF179	32p	OC71	12p	2N3055 60p	ZTX302 15p
		BF181	25p	OC72	12p		7TX500 16p
AFI17 2		BF194	15p			2N3442	
	8p	BF195	15p	OCBI	12p	140р	ZTX503 16p
BC107 I	0p	BFY50	22p	OC82D	12p	2N3702 13p	40362 58p

LINEAR I.C.'s (D.l.L.) 709 50p 741, 50p 710 50p 748, 50p ZENER DIODES 400mW 5% 3:3V to 30V, 15p. DIL Socket 14 and 16 pin. 16p

DIODE	•				
RECTIF				SIGNAL	
BY127	1250∨	I A	12p	OA85	7 p
BZVIO	800 V	6A	25p	OA90	5 p
BZY13	200V	6A	20p	OA91	5 6
IN4001	50 V	IA	7p	OA202	7
IN4004	400 V	ÍΑ	8p	IN4148	5 p
IN 4007	1000V	ÍΑ	12p	BAT14	80

BRUSHED ALUMINIUM PANELS

 $12in \times 6in = 25p$; $12in \times 2\frac{1}{2}in = 10p$; $9in \times 2in = 7p$.

SLIDER POTENTIOMETERS
86mm x 9mm x 16mm, length of track 59mm
SINGLE 10kΩ, 25kΩ, 50kΩ, 100kΩ, log or 1in
DUAL GANG 10kΩ + 10kΩ, etc, log or lin Knob for above FRONT PANEL

20 gauge panel 12 in \times 4 in with stots cut for use with slider pots. Grey or matt black finish, complete with fixings for 4 pots.

MULLARD POLYESTER CAPACITORS C296 SERIES 400V: $0.001\mu\text{F}$, $0.0015\mu\text{F}$, $0.0015\mu\text{F}$, $0.0021\mu\text{F}$, $0.0022\mu\text{F}$, $0.0033\mu\text{F}$, $0.0047\mu\text{F}$, $2\frac{1}{4}\text{p}$, $0.0068\mu\text{F}$, $0.015\mu\text{F}$, $0.0222\mu\text{F}$, $0.033\mu\text{F}$, $1.001\mu\text{F}$, 4p, $0.15\mu\text{F}$, 6p, $0.22\mu\text{F}$, $7\frac{1}{4}\text{p}$, $0.33\mu\text{F}$, $1.001\mu\text{F}$, $0.01\mu\text{F}$, $1.001\mu\text{F}$, $0.015\mu\text{F}$

MULLARD POLYESTER CAPACITORS C280 SERIES 250V P.C. mounting: 0.01µF, 0.015µF, 0.022µF, 3p. 0.033µF, 0.047µF, 0.068µF, 3†p. 0.1µF, 4p. 0.15µF, 0.022µF, 5p. 0.33µF, 6†p. 0.47µF, 8‡p. 0.68µF, 11p. 1.0µF, 13p. 15µF, 20p. 22µF, 3†p. 0.47µF, 8‡p. 0.68µF, 11p. 1.0µF, 13p. 15µF, 20p. 22µF, 3†p. 0.47µF, 8†p. 0.4

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MULLARD C437 SERIES 100/40, 160/25, 250/16, 400/10, 640/6-4, 800/4, 1000/2-5, 9p. 100/64, 160/40, 250/25, 400/16, 640/10, 1250/4, 1000/6-4, 1600/2-5, 12p. 160/64, 250/40, 400/2-5, 640/16, 200/4, 1000/10, 1600/6-4, 250/2-5, 15p. 250/64, 400/40, 640/25, 3200/4, 1000/16, 1600/10, 2500/6-4, 4000/2-5, 18p.

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			JACK PLU
VEROBOARD			JACK PL
2½ × 3½ 2½ × 5 3½ × 5 3½ × 5 17 × 2½ 17 × 3½ (plain) 17 × 3½ (plain) 17 × 3½ (plain) 17 × 2½ (plain) 2½ × 5 (plain) 2½ × 5 (plain) 2½ × 5 (plain)	0·1 22p 24p 24p 27p 75p 100p	0-15 16p 24p 27p 571p 78p 82p 60p 42p 12p 11p	Standard so Standard in Stereo scre Standard so Stereo sock D.I.N. PL 2 pin, 3 pin Plug 12p. 4 way scree 6 way scree
pot face cutter	42p	42p	BATTERY
Pkt. 50 pins	20p	20p	9V mains p

JACK PLUGS AN	ID SC	CKETS	
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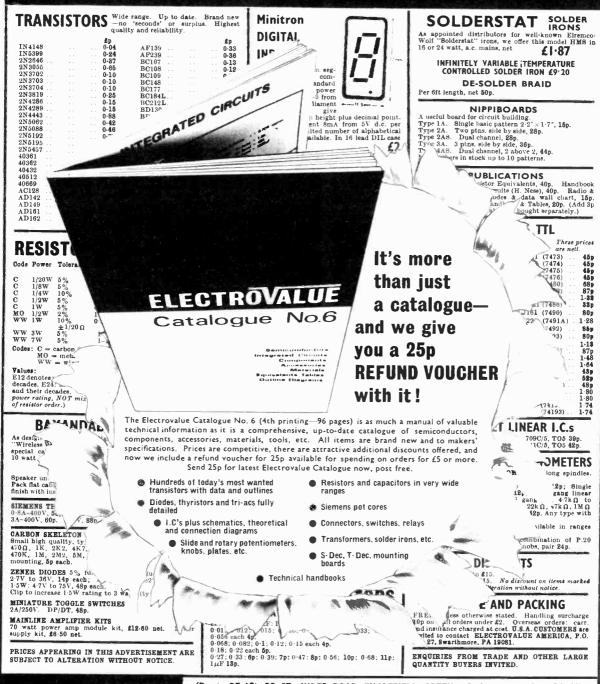
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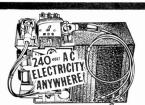
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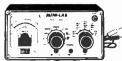
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